

REPORT
ON
THE DESIGN, INSTALLATION AND OPERATION
OF
A CRUSHING PLANT
AT
THE BRAND QUARRY, LITHONIA, GEORGIA
FOR
THE UTILIZATION OF WASTE MATERIAL
RESULTING FROM
THE OPERATION OF THE QUARRY

approved. May 20, 30

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THE DESIGN, INSTALLATION AND OPERATION

OF

A CRUSHING PLANT

A THESIS

PRESENTED TO THE CIVIL ENGINEERING DEPARTMENT

OF

GEORGIA SCHOOL OF TECHNOLOGY

BY

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DEGREE OF MASTER OF SCIENCE

IN

CIVIL ENGINEERING

ATLANTA, GEORGIA

June 1930

INTRODUCTION

One of the greatest problems of modern industry is the disposal, and profitable disposal, if possible, of the enormous accumulation of waste material. The successful solution of this problem for one particular phase of industry, namely, the Brand Granite Quarry located at Lithonia, Georgia, is discussed in this treatise.

The annual production of this Quarry, one of a number operated by the Lithonia Granite Company of Cleveland, Ohio and Lithonia, Georgia, is one hundred and seventy-five thousand linear feet of curbing, five hundred thousand paving blocks, two thousand tons of rubble, and one thousand tons of special cut stone for building. Such production naturally accumulates a great amount of waste material. The area of the Quarry would soon be completely covered by this material unless it was disposed of. Due to its great weight moving this material is very expensive, and, it was therefore, necessary to find some way of disposing of it permanently with a minimum amount of labor and expense.

The Board of Directors of this Company finally solved their problem by turning this waste into an asset, through the erection of a crushing plant. Since the crushed stone was to be shipped, it was necessary to locate their plant on the Company's spur track. The plant was built so the trucks could be dumped at the level of the crusher mouth and the bins could be unloaded directly into the railroad cars by means of shutes. This eliminated the use of mechanical means of feeding the crusher and unloading the bins. All the roads in use on the

quarry intersect near this point. This location reduced the estimated cost of handling considerably.

Crushed granite is used by railroads as ballast. It is an excellent base for penetration and sheet asphalt roads. It is used as the coarse aggregate in making concrete. Granite Sand, a by-product of the Crushing Plant, is used as the fine aggregate for making concrete and for spreading on penetration roads where an excess of asphalt has been used. These uses provide a good market for the products of the plant. The output for one year, in excess of regular orders, was contracted for by the Georgia Railroad before the plant was completed.

In quarrying granite it is necessary to separate or raise immense slabs from the parent body and to open ledges. This particular formation is solid as far down as soundings have been taken and has no natural bed.

The raising or separating is done by drilling a four inch hole to the depth it is desired to give the ledge. This hole is generally placed on a rise or crown of the formation with the idea of running the ledge out to a feather edge over as large an area as possible, thus eliminating costly channeling or trenching. This hole is drilled with an air or steam drill.

Upon completion of the drilling the hole is cleaned out and loaded with a charge of blasting powder. An amount as small as a table-spoonful is sometimes used for the first shot. The powder is placed in the hole and tamped with clay to hold the charge. It is exploded with a time fuse.

A large amount of the explosive would blow out of the hole. It is impossible to tamp it sufficiently to hold it down. It is necessary for a man to place his ear against the granite to hear the explosion of the first charge. This operation is repeated using a larger amount of the explosive each time until a rift opens at the bottom of the hole. After each shot the hole is cleaned and rift probed for with a test hook. This tool is made of iron and is shaped like the letter "L". After the opening of the rift is verified the size of the charge is increased considerably. As the rift spreads soundings are taken with a large hammer. The granite is hit a fairly hard blow with hammer at regular intervals until the end of the rift is located. A trained ear can detect the end by the difference in sound as the rift runs out. The grain runs parallel with the top so the rift extends in a circle parallel with the top. When the amount of explosive used requires a can of powder the shooting is stopped. This generally opens the rift to a radius of approximately fifty feet. An inch iron pipe is then cemented in the hole. A compressed air line carrying a pressure of one hundred pounds per square inch is attached to the pipe and compressed air is gradually let into the rift forcing it to completion. The opening of the rift produces tension between the lifted bed and the parent body. This tension increases as the rift spreads. This condition enables the operation to be carried to completion with compressed air. The radius at which this operation would become effective has been determined by actual experiment to be about fifty feet. Very often an area of several acres is lifted in one operation. If the rift does not break through

on all sides the bed is channeled free on the bound side releasing it entirely. This forms a ledge of workable granite. The ledge is faced and is then ready for quarrying.

Channeling is the most expensive operation in raising the ledge. It wastes a lot of granite that could be disposed of more profitably. It requires a considerable amount of time, labor and dynamite. It causes the suspension of all other work in its immediate vicinity. It is necessary, however, because the bed must be entirely free to be worked. The end of the rift is located and a series of two inch holes are drilled to the bottom of the rift. The holes are staggered in order to make a trench when dynamited. The same amount of explosive is placed in each hole but the fuses are of varying length. The order of fire is Number One hole first, Number Two hole second, and so on over the entire line. The dynamiting of hole Number One clears the way and aids hole Number Two. This causes the holes to blow on horizontally, thereby opening up the trench. At the completion of the dynamiting of the last hole the trench is fairly well cleaned out and the bed has been freed. This completes the operation of channeling. This method was worked out by actual experience.

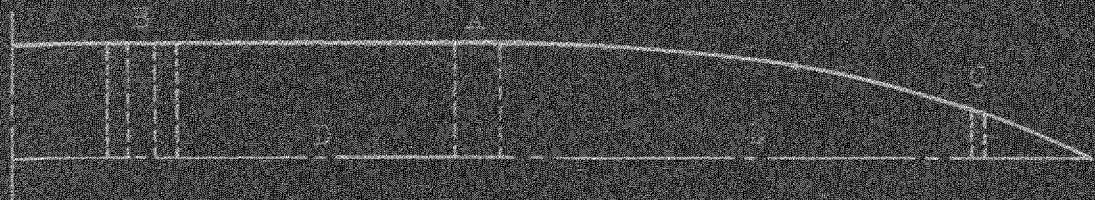
Facing and Quarrying are done by what is known as the plug and feather method. A series of half inch holes six inches deep at six to eight inch intervals in line are sunk at right angles with rift with a small air drill known in the vernacular of the quarry as monkeys. The plug is made of a good grade of steel, is six to eight inches long, and is wedge shaped. The feathers are made of half round iron and are about an inch shorter than the plug. The feathers are placed in the holes and the plug inserted. A laborer moves down the line of

holes giving each plug a fairly hard blow with a large hammer. This is repeated until the section of granite splits off. Trailers designed especially for this work are used to haul the granite to the sheds for cutting and dressing.

These operations naturally produce a large amount of waste. The granite broken up in channeling can be used for crushing only. Part of the stone from the facing operation can be disposed of as rubble but the majority of it goes to the crusher. In the early operation of the quarry the lift holes were drilled too close to each other causing the ledges to overlap. In that case it is necessary to remove tons and tons of granite before a new ledge can be started. The stone thus removed can be used for crushing only. Other sources of waste are from the manufacture of paving blocks and the cutting and dressing of curbing and special work for buildings.

From this discussion the necessity of a Crushing Plant for the profitable operation of the Granite Quarry can readily be understood.

PLAN OF SECTION



Cross Section of Building

Depth of section unknown

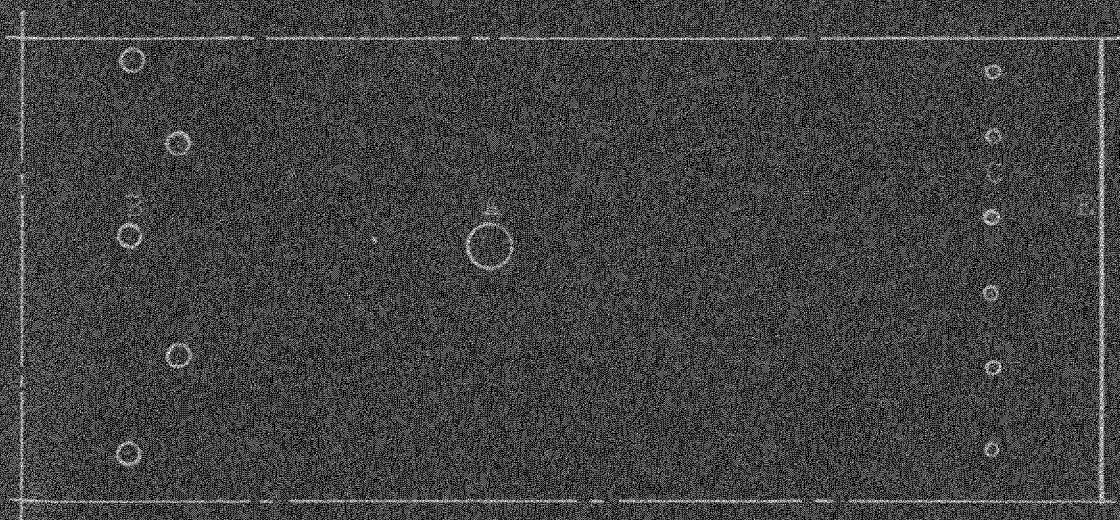
A - 4' hole for raising ledge

B - 4' hole for raising ledge

C - 4' hole for raising ledge

D - 4' hole for raising ledge

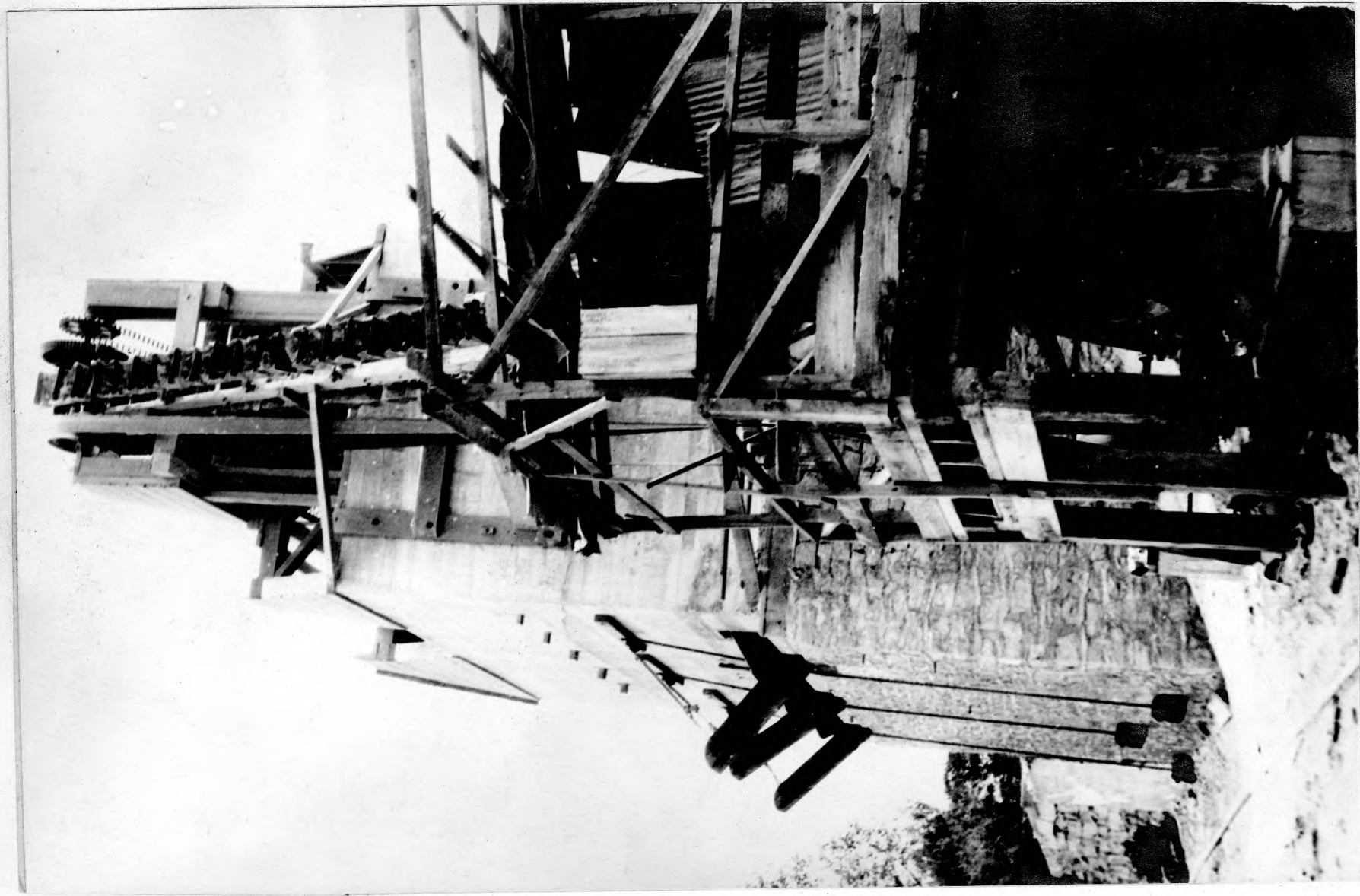
E - 4' hole for raising ledge



PLAN OF SECTION

CHAPTER NO. 1

PICTORIAL SECTION



THE CRUSHING PLANT



DIFFERENT SIZES OF REFUSE OR SPAWL
ACCUMULATED FROM QUARRY OPERATIONS





ACCUMULATION OF SPAWL

THIS VIEW SHOWS A STRATA OF GRANITE THAT WAS RUINED BY THE USE OF TOO MUCH EXPLOSIVES. THE STRATA WILL, IN ALL PROBABILITY, HAVE TO BE COMPLETELY REMOVED. FROM ALL APPEARANCES IT CANNOT BE FACED. THIS OPERATION IS VERY EXPENSIVE. THE FOREMAN IN CHARGE OF THE BLASTING SQUAD MUST BE AN EXPERIENCED MAN. MANY MISTAKES LIKE THIS WOULD RUIN THE STONE FOR QUARRYING AND FORCE THE COMPANY OUT OF BUSINESS.



VIEW OF QUARRY OPERATION AFTER LEDGE HAS BEEN FACED. THE GROUP OF FOUR MEN ARE DRILLING HOLES FOR SPLITTING OFF SECTIONS OF GRANITE BY THE PLUG AND FEATHER METHOD. AT THE EXTREME RIGHT A MAN IS PREPARING A SECTION FOR SPLITTING TO DIMENSIONS FOR CUTTING, ANOTHER USE OF THE PLUG AND FEATHER METHOD. A PIECE OF DIMENSIONED STONE IS SHOWN ON THE TRUCK. TWO MEN ARE LOADING THE TRAILER FOR TRANSPORTATION TO THE SHED. THE MAN IN THE FOREGROUND IS CLEANING THE QUARRY. ACCUMULATIONS OF SPAWL MAY BE SEEN BEYOND THE OPERATIONS.



ANOTHER VIEW OF THE OPERATION OF THE QUARRY. THE MAN IN THE REAR IS PLACING PLUGS AND FEATHERS. THE MEN IN FRONT ARE SPLITTING THE STONE.



FACES OF TWO LEDGES THAT ARE BEING QUARRIED TOGETHER.



TWO VIEWS OF CUTTING SHED, ANOTHER
SOURCE OF SPAWL. IN THE LOWER PIC-
TURE THE STONE RESTING ON THE TIMBER
HAS JUST BEEN BROUGHT FROM THE QUARRY.



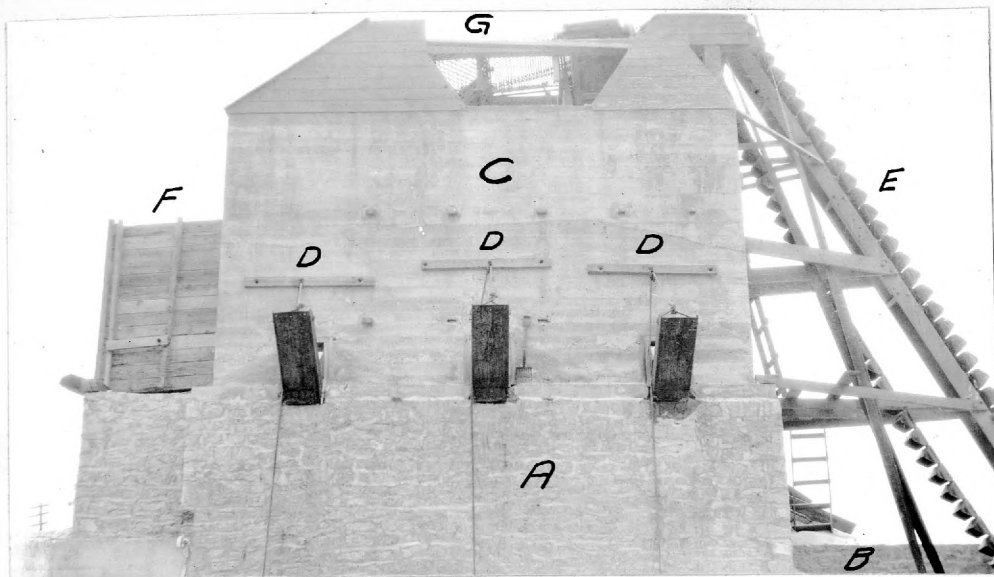


FINISHED PRODUCT FROM THE CUTTING
SHEDS. THE LOWER PICTURE SHOWS AN
ACCUMULATION OF SPAWL.



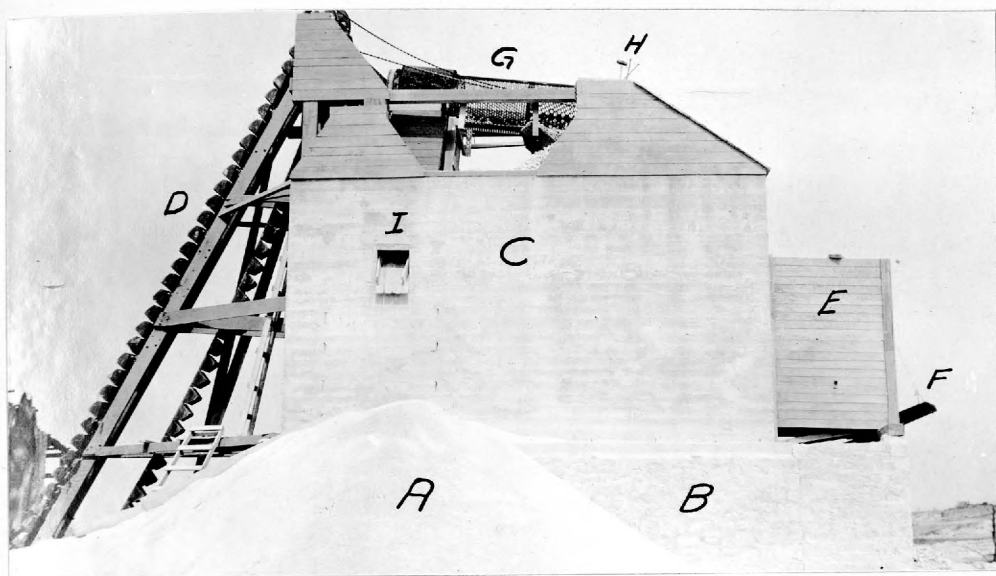


PAVING BLOCKS. THE BLOCKS ARE MADE OF STONE THAT BREAKS IN QUARRYING, OF STONE THAT IS CUT WRONG, OF SPAWL THAT IS TOO LARGE FOR THE CRUSHER. AT TIMES IT IS NECESSARY TO QUARRY ESPECIALLY FOR THIS KIND OF WORK. THE BLOCKS ARE USED IN PAVING STREETS THAT HAVE UNUSUALLY HEAVY TRAFFIC. THEY ARE LAID ON A CONCRETE FOUNDATION WITH A SAND CUSHION BETWEEN THE BLOCKS AND THE CONCRETE. THE SPACE BETWEEN THE BLOCKS IS FILLED WITH ASPHALT. THE BLOCKS ARE 6" x 6" x 12".



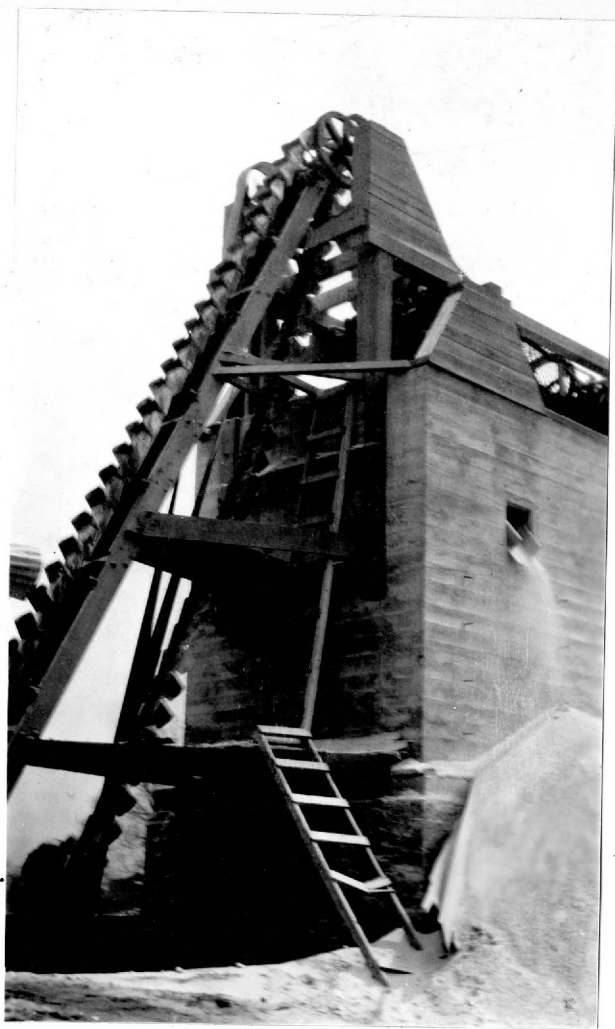
SIDE OF CRUSHER FACING RAILROAD TRACK.
THIS VIEW SHOWS:

- (A) RUBBLE MASONRY FOUNDATION
FOR BINS
- (B) RETAINING WALL
- (C) BINS
- (D) UNLOADING SHUTES
- (E) ELEVATOR
- (F) TAILING BIN
- (G) SCREEN



SIDE OF CRUSHER AWAY FROM RAILROAD TRACK

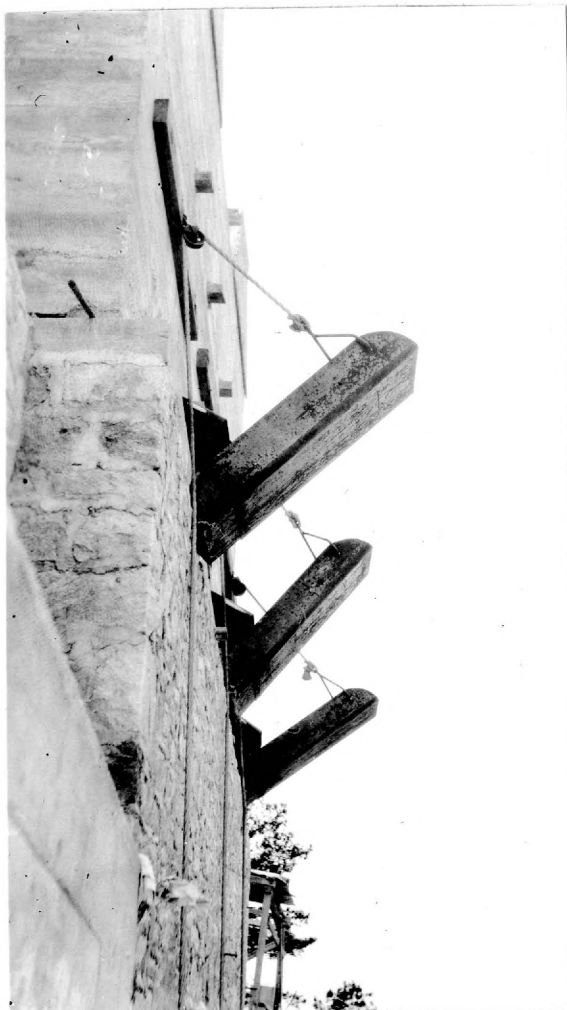
- (A) SAND PILE
- (B) CONCRETE FOUNDATION FOR BINS
- (C) CONCRETE BINS
- (D) ELEVATOR
- (E) TAILING BIN
- (F) UNLOADING SHUTE OF TAILING BIN
- (G) SCREEN
- (H) HAMMER AND HOOKS FOR DIS-
LODGING STONES CAUGHT IN
SCREEN
- (I) SAND SHUTE



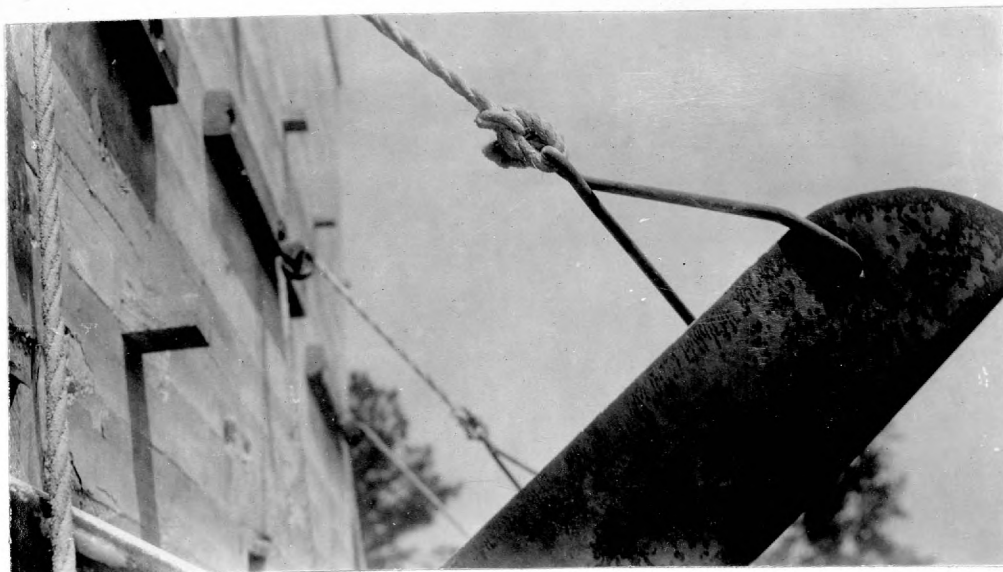
ELEVATOR CONSTRUCTION. AT RIGHT CENTER
THE SAND SHUTE MAY BE SEEN IN OPERATION.
IN REAR A RAILROAD CAR IS BEING LOADED.



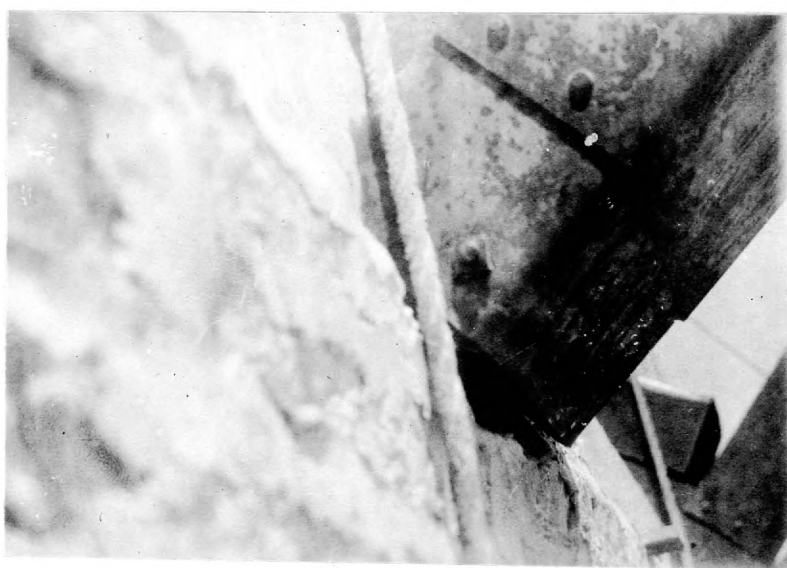
END VIEW OF PLANT. IN THE FOREGROUND
IN THE TAILING BIN AND ITS UNLOADING
SHUTE. AT THE EXTREME RIGHT MAY BE
SEEN THE UNLOADING SHUTES OF THE BINS.



UNLOADING SHUTES. THIS VIEW SHOWS THE CONSTRUCTION AND METHOD OF OPERATION OF THE UNLOADING SHUTES. THE WEIGHTS ARE NOT IN THE PICTURE.



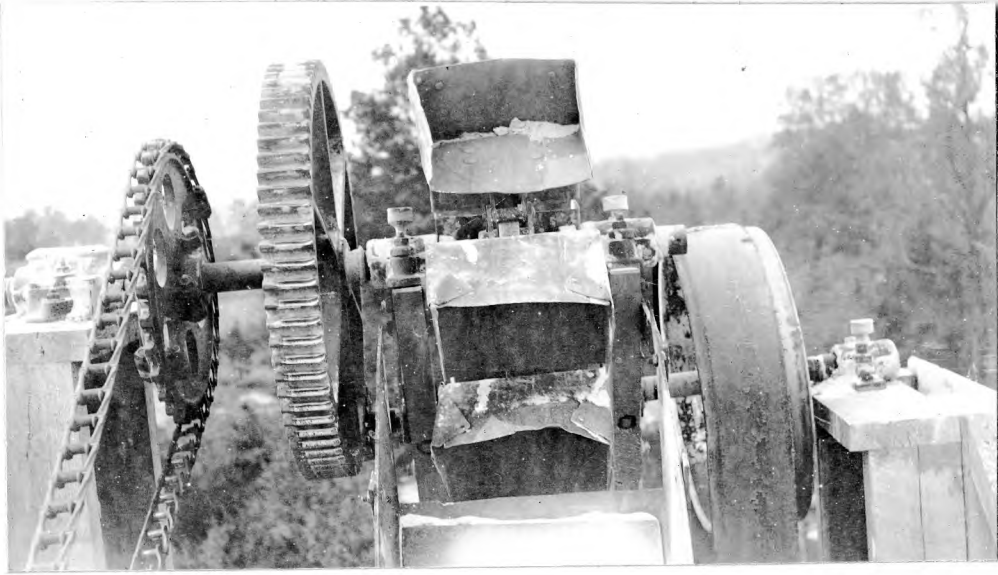
CLOSE UP OF SHUTES SHOWING METHOD OF
ATTACHING WEIGHTS FOR OPERATION. LOWER
PICTURE SHOWS CONSTRUCTION OF SHUTES AND
HINGE.



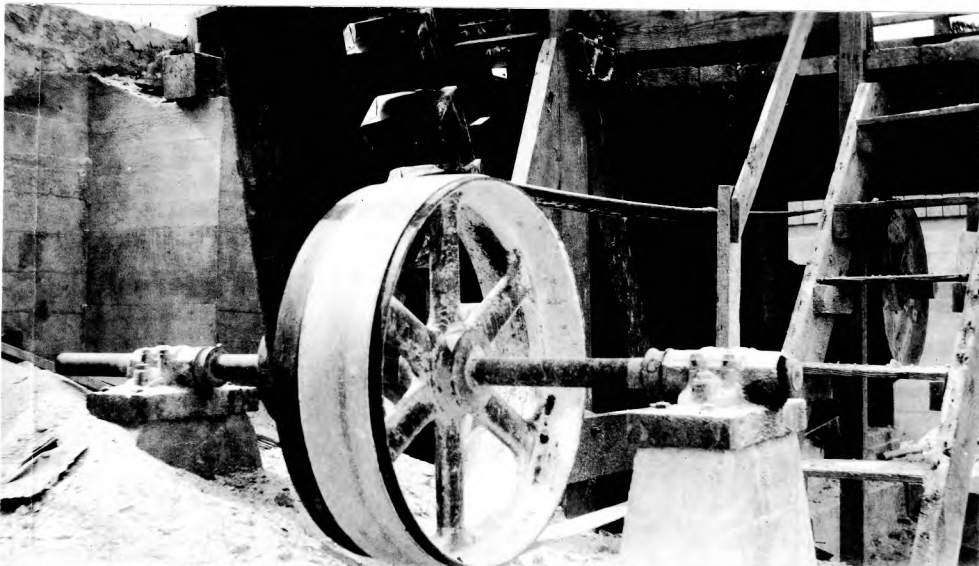


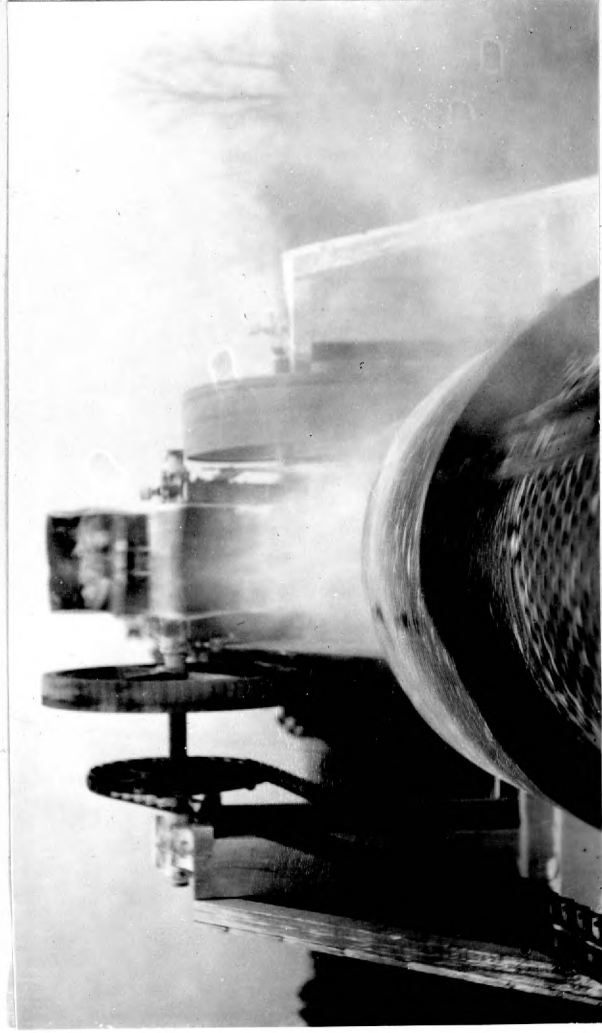
MOTOR HOUSE. TRANSMISSION LINE LEADING TO MOTOR HOUSE. LOWER PICTURE SHOWS INSTALLATION OF CRUSHER. THIS PICTURE WAS MADE WHILE PLANT WAS IN OPERATION.



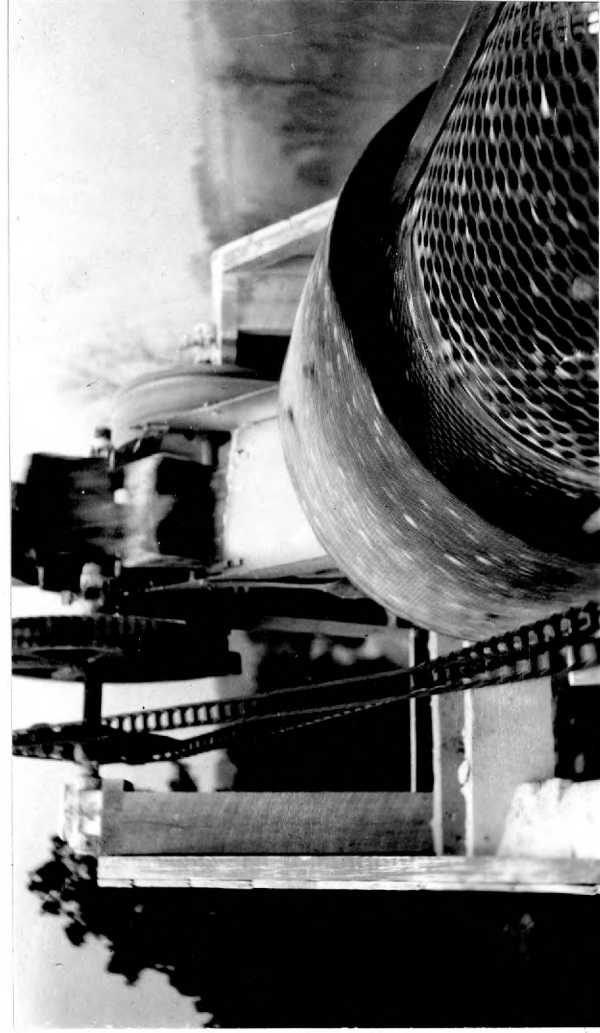


INSTALLATION AND POWER TRANSMISSION AT TOP OF ELEVATOR. THE BELT LEADS TO THE CRUSHER THROUGH THE COUNTERSHAFT AND THE CHAIN TURNS THE SCREEN. LOWER PICTURE SHOWS COUNTERSHAFT INSTALLATION. LARGE PULLEY RECEIVES POWER FROM THE CRUSHER. SMALL PULLEY TRANSMITS IT TO ELEVATOR.





TWO VIEWS OF SCREEN AND ELEVATOR ASSEMBLY. THE SAND JACKET IS SHOWN IN POSITION ON END OF SCREEN. BOTH PICTURES WERE MADE WHILE PLANT WAS IN OPERATION.





SCREEN. THIS VIEW SHOWS THE THREE
SECTIONS OF THE SCREEN, THE REINFORCE-
MENT AND THE SAND JACKET. LOWER PIC-
TURE SHOWS POWER TRANSMISSION TO SCREEN.





TWO VIEWS OF TRUCKS DUMPING SPAWL ON
LOADING PLATFORM OF CRUSHER.





PRODUCT OF CRUSHER IN ONE SECTION OF
BINS.

CHAPTER NO. II

ASSEMBLY AND DESIGN OF PLANT

In the design of a plant of this type the first consideration is given to the amount of material available and its rate of accumulation. The quarry has been in operation for several years without a crushing plant and there is quite an accumulation of spawl. The superintendant of the quarry made a survey and estimated that a crusher of twenty tons hourly capacity would take care of the waste at its present rate of accumulation and gradually eliminate the accumulation of other years. Several manufacturers of crushers were requested to send in specifications and bids. A crusher manufactured by the Universal Crusher Company, 625 C Avenue W, Cedar Rapids, Iowa, and distributed by R. S. Armstrong Bros., 676 Marietta Street, N. W. Atlanta, Georgia was decided upon.

Exclusive of nuts and bolts this crusher has fewer parts than any other crusher manufactured. All parts are readily accessible and can be quickly removed or installed by such help as is usually found about the ordinary plant. No long shut-downs are necessary.

This crusher combines the important crushing principles of the Dodge type and Blake type crushers. The Dodge type using a direct blow for crushing and the Blake type a grinding action. A crushing and grinding action is produced by the use of high bearings and radial toggle action, which tend to force the feed and increase the capacity. Because of this special combined vertical and horizontal action of the movable jaw the product from this crusher is uniform. There are two crushing strokes to each revolution of the shaft.

A primary crushing blow comes at the top of the jaws where most needed and a secondary or finishing stroke at the bottom of the jaws.

Another important feature of this crusher is the adjustment of the jaws. It can be made almost instantly by means of a hand wheel which controls and operates the adjusting wedges. No other adjustments or changes are necessary.

The safety toggle is of hard cast iron and inexpensive. It is designed to withstand the hardest shocks of the crushing operation, but will break in case anything uncrushable gets between the jaws, and in this way protects the vital and expensive parts of the crusher.

The bearings, the heart of the crusher, are of the highest quality phosphor bronze and larger than the average for this type machine. They are movable, dust proof, and interchangeable.

The side bearings are ring oiled, the oil chamber being sufficiently large to take care of several hours run. Each bearing has large grooves through which oil flows, insuring a thin film of oil about the shaft at all times. A special felt oil retaining ring is used on the center bearing as well as on the side. This feature together with a splash feeding system has proven to be a satisfactory and economical oiling system.

The heavy eccentric shafts are of high carbon and alloy steel accurately machined, highly polished and brought to a perfect bearing surface.

The jaws and side plates are of highest quality manganese steel. All jaws, excepting some stationary jaws that are wedge shaped for special crushing are reversible. Cheek and side plates are extra heavy. Straight, regular curve, or heavy curve corrugated jaws are furnished depending upon the nature of the material to be crushed and the firmness desired.

The main frame work of the crusher is very substantial and is designed to easily withstand the severe shocks of the crushing operation. The frames are machined and all parts well fitted.

The specifications and special features are as listed.

Stock Number - 836

Jaw opening - 8" x 36"

Revolutions per minute - 175 to 225

Size of fly wheel - 36"

Weight on skids - 11700 lbs.

Horse Power - 45 to 65

Capacity for 10 hour day: $2\frac{1}{2}$ " - 200 to 300 tons

$1\frac{1}{2}$ " - 120 to 175 tons

$\frac{3}{4}$ " - 95 to 150 tons

Owing to wide variation in the friability of materials the capacities given here are approximate and based on ordinary stone.

Very simple in design, east to install and can be operated without expert workmen.

Two positive crushing blows to each revolution of the shaft.

Equipped with reversible, corrugated jaws of best grade manganese steel, very durable and unbreakable.

Steel split pitman with removable bearing.

Heavy high carbon and alloy steel eccentric shafts.

Three bearings of phosphor bronze and dust proof.

Reliable and effective lubricating system which eliminates all heating troubles.

A toggle system which protects the vital and expensive parts of the crusher.

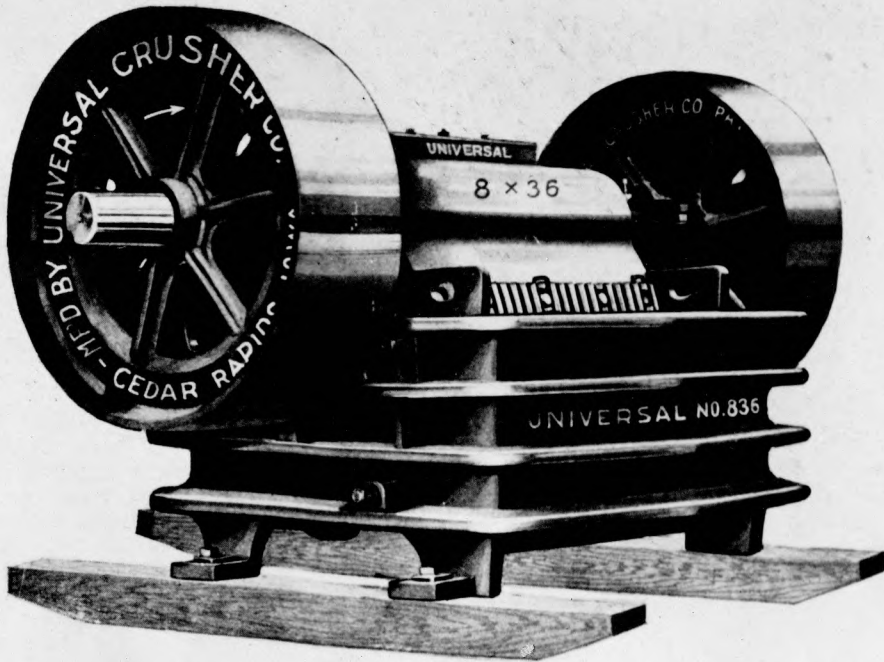
Instant adjustments to crush any desired size without stopping machine or using tools.

Fly wheels serve as pulleys.

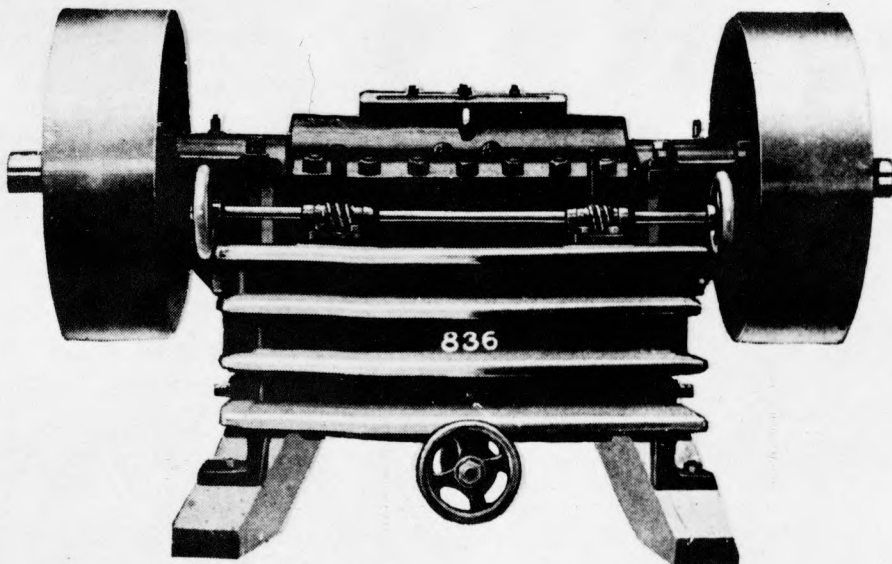
This is primarily a gravel and rejection crusher.

Data was submitted showing that when set to crush granite to a maximum size of two and one-half inches it would average about twenty tons per hour of the three sizes shown. The work day for the crusher is nine hours. This output for the day running full time would be approximately one hundred and eighty tons.

The type of jaws used was determined in the laboratory of the manufacturer. Samples of the material to be crushed were tested using the three types of jaws manufactured, namely, the straight, regular curve and heavy curve types. The regular curve gave the best results and this type was installed in the crusher.



UNIVERSAL CRUSHER NO. 836



REAR VIEW

SHOWING THE DOUBLE WORM AND GEAR ADJUSTMENT

No.	NAME OF PARTS
1	Base
2	Caps for base (2)
3	Pitman
4	Movable Jaw—Manganese
5	Stationary Jaw—Manganese
6	Key Plates, Right & Left, Mang.
7	Side Plates, Right & Left
8	Side Bearing Brass (2)
9	Pitman Brass
10	Toggle Plate
11	Eccentric Shaft
12	Fly Wheels (2)
13	Thrust Plates, Right & Left
14	Pitman Key Wedge
15	Toggle Plate Bearing Wedge
16	Adjusting or Pull Wedge
17	Pulley
18	Oil Box Cover
19	Cross Bar
20	Adjusting Hand Wheel, Round Hole
20X	Adjusting Hand Wheel, Square Hole
21	Tension Rod Hand Wheel
22	Inside Spring Collar
23	Outside Spring Collar
24	Adjusting Rod
25	Tension Spring
26	Tension Rod
27	Tension Rod Pin
28	Stationary Jaw Clamp Bolts (2)
29	Pitman Clamp Shims
30	Oil Rings (2)
31	Heel Plates, Right & Left
32	Pitman Toggle Seat
33	Adjusting Wheel Collar
34	Adjusting Shaft Worm Gear (2)
35	Adjusting Shaft Worm (2)
36	Adjusting Shaft
36X	Adjusting Shaft
37	Bracket for Worm Gear (2)
38	Stationary Jaw Wedge
39	Side Bearing Packing (4)
40	Pitman Packing (2)
41	Adjusting Ratchet Wheel
42	Adjusting Ratchet Handle
43	Adjusting Ratchet Dog
44	Gib Head Key for Fly Wheel (2)

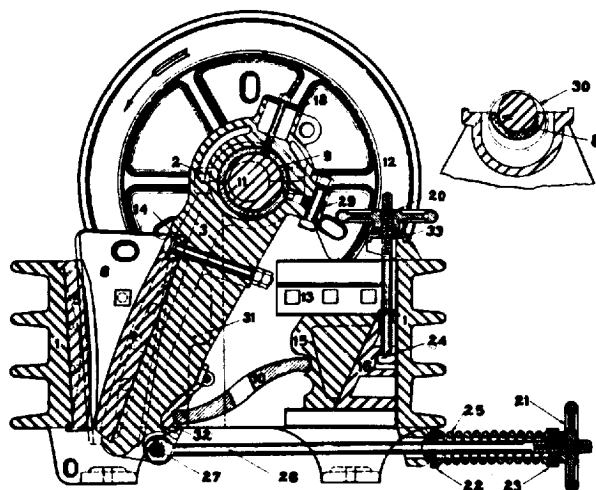
SPECIFICATIONS

Crusher No. 836

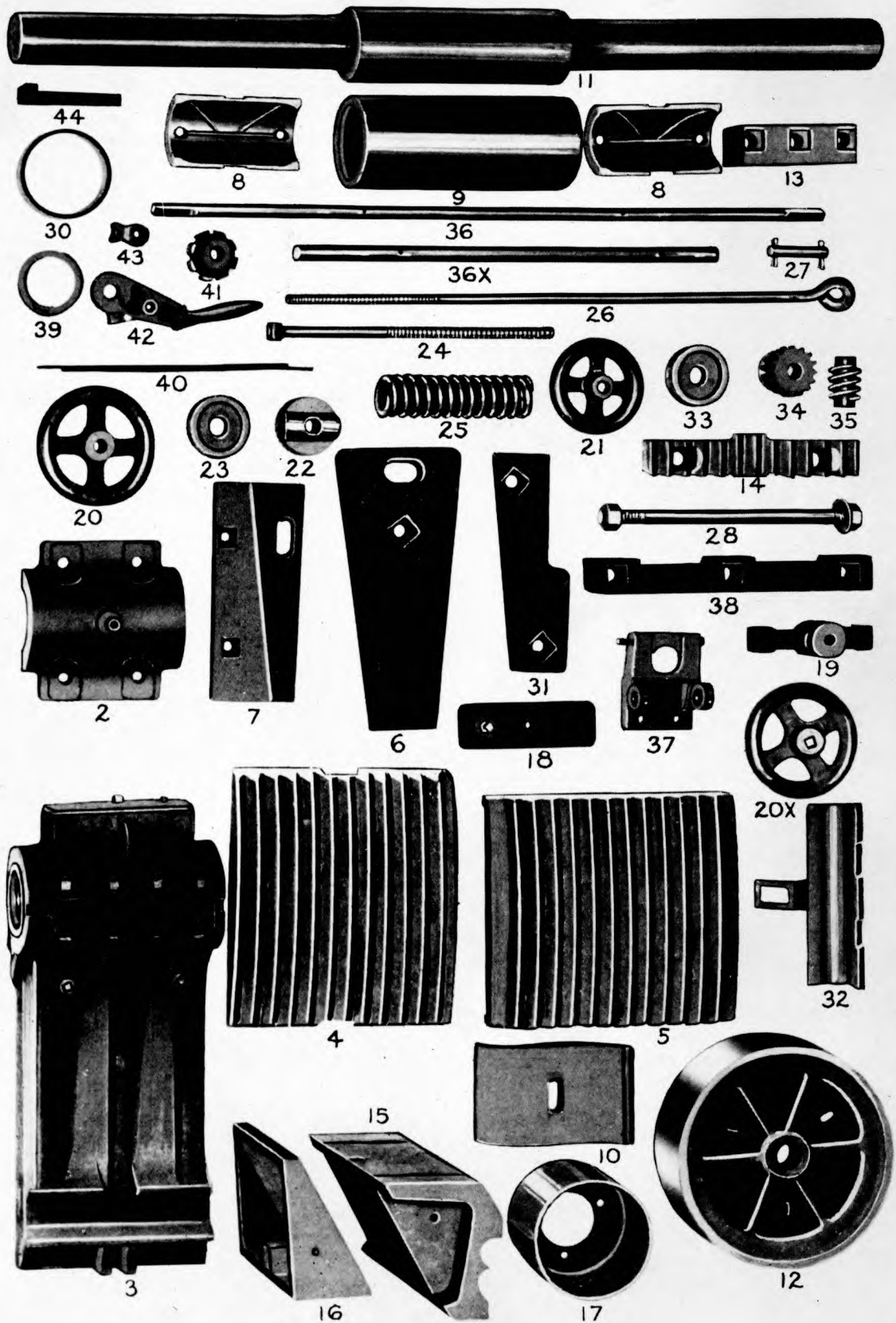
Jaw Opening
8 x 36Speed R. P. M.
175 - 225Weight on Skids
11,700Horse Power
45 - 65Capacities in tons
per 10 hrs. $2\frac{1}{2}$ " - 200-300 $1\frac{1}{2}$ " - 120-175 $\frac{3}{4}$ to 1" - 95-150

ASSEMBLY

GRAVEL & REJECTION CRUSHERS



UNIVERSAL CRUSHER PARTS ILLUSTRATED



The problem of the crusher having been solved, the power plant was next in line in importance. All of the machinery on the quarry is electrically operated. A power line of 2200 volts extends across the quarry. An electrician was already on the payroll. This condition naturally favored the use of electricity for power. When the samples of granite were tested in the laboratory of the crusher manufacturer it was determined that forty-five horse power was necessary to operate the crusher. Bids and specifications for a motor developing this horse power were reviewed. Crusher operators were interviewed and their opinions carefully weighed. A motor manufactured by the Westinghouse Electric and Manufacturing Company was selected.

The motor is known commercially as Type CW wound rotor induction motor, equipped with sealed sleeve bearings, for constant and varying speed continuous duty service. The speed of operation of the entire plant is governed by the R. P. M. of the crusher which ranges from 175 to 225. The Board of Directors decided to operate the crusher at a speed a fraction higher than recommended. The size of the pulley on the crusher is thirty-six inches. The rated R. P. M. of the motor is 870. Using an eight inch pulley would give the crusher a calculated R. P. M. of 193. The motor, when loaded, actually operates at about 842 R. P. M. This reduced the speed of the crusher to 187 R. P. M.

This type of motor is particularly adaptable wherever large starting torques with low starting current are required.

In both rotor and stator dual treated windings (Doubly impregnated coils) are effectively protected against the deteriorating actions of oils, moisture, acids, alkalies, grit and dust. Mica insulated collectors are used.

Unit frame construction insure a light, strong compact motor and prevents weaving of laminations. The unit frame is open type and provides support for stator core. The supporting rings on coil ends prevent vibration or coil movement under severe operating conditions.

Large openings in end brackets permits easy access to brushes. Sturdy adjustable conduit boxes contain ample space for making all necessary connections.

A pushed on keyless type collector assembly is used with mica insulated bushing of high dielectric strength. Brazed joints insure against failure from vibration.

Sealed sleeve bearings perform a three fold duty in preventing dust and grit from entering the bearings, in preventing oil from escaping, and in providing a film of oil between the shaft and bearings to absorb the shocks and vibrations encountered in service.

Efficient transmission of heat from the windings is assured by combination slot cells which eliminate dead air spaces.

Strong, tough, axel steel shaft is used on the rotor.

The brackets have flat surfaced openings so that either a perforated or solid cover may be bolted over them to provide additional protection to the motor. A metal canopy may be added to make the motor drip proof. The brackets have

a machined ring groove to fit the motor frame insuring perfect alignment of bearings.

The motor is equipped with a primary and secondary conduit boxes to facilitate installation.

The motor is equipped with a rockwood paper pulley.

A non-reversing drum controller providing thermal overload and low voltage protection is used for starting. It is automatic in operation.

Specifications and summary of special features are listed below.

Type CW Two-Bearing Motors

Voltage - 2200 A. C.

Phase - 3

Cycles - 60

H. P. - 50

R. P. M.- 870

Frame - 664-C

Degree - 40

Large starting torque with low starting current.

Doubly impregnated coils.

Mica insulated collectors.

Unit frame construction, supportings rings on coil ends.

Easy access to brushes.

Sealed sleeve bearings.

Slot cells which eliminate dead air spaces.

Brackets with flat surfaced openings.

Primary and secondary conduit boxes.

Pushed-on, keyless type collector assembly.

Mica insulated bushing of high dielectric strength.

Brazed joints.

Rockwood paper pulley.

Non-reversing drum controller.

Thermal overload and low voltage protection.

Radio frequency tests between each individual turn of wire.

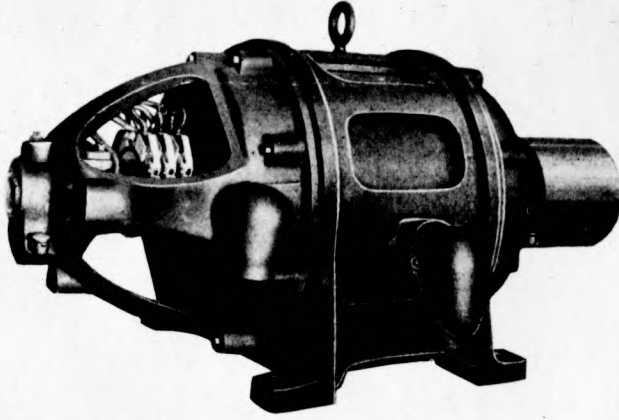
Strong, tough, axel steel shaft.

Balanced design and construction.

TYPE CW WOUND ROTOR INDUCTION MOTOR

Equipped with Sealed-Sleeve Bearings

For Constant and Varying Speed Continuous Duty Service



Rotor

Collector Assembly

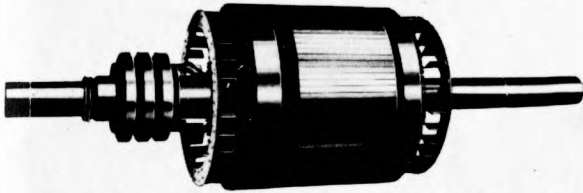


FIG. 6—COILS DOUBLE IMPREGNATED, IN ALL RATINGS, TO RESIST DETERIORATING ACTION OF MOISTURE, OILS, ACIDS, ALKALIES, DUST AND GRIT. MICA INSULATED COLLECTORS, USED ON 600 FRAME SIZES AND ABOVE

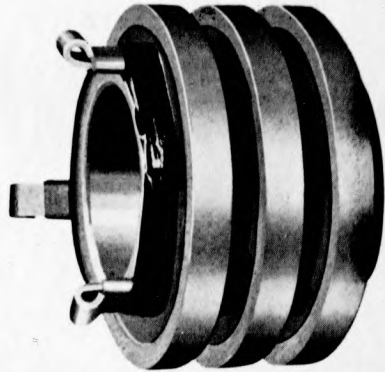


FIG. 16—PUSHED-ON, KEYLESS TYPE COLLECTOR ASSEMBLY—MICA INSULATED BUSHING OF HIGH DIELECTRIC STRENGTH—BRAZED JOINTS—UN-AFFECTED BY VIBRATION

Stator and Frame

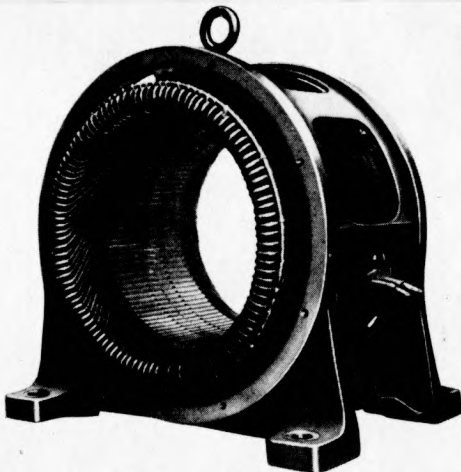


FIG. 10—OPEN TYPE FRAME PROVIDES SUPPORT FOR STATOR CORE. UNIT FRAME CONSTRUCTION PREVENTS WEAVING OF LAMINATIONS. SUPPORTING RINGS ON COIL ENDS PREVENT VIBRATION OR COIL MOVEMENT UNDER SEVERE OPERATING CONDITIONS

Bearing

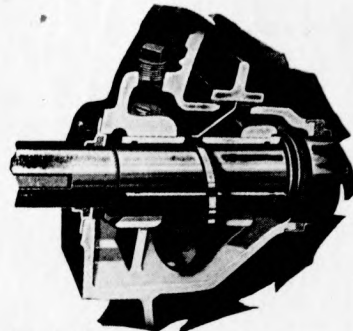


FIG. 3—CONSTRUCTION DETAILS OF THE SEALED SLEEVE BEARING

TYPE CW TWO-BEARING MOTOR

EQUIPPED WITH SEALED-SLEEVE BEARINGS WITHOUT SHAFT
EXTENSION ON END OF MOTOR OPPOSITE PULLEY END WITH
SLIDE-RAILS

50 HP 2200 Volts 60 Cycles 3 Phase

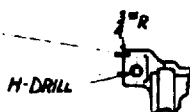
870 R. P. M.

664-C Frame

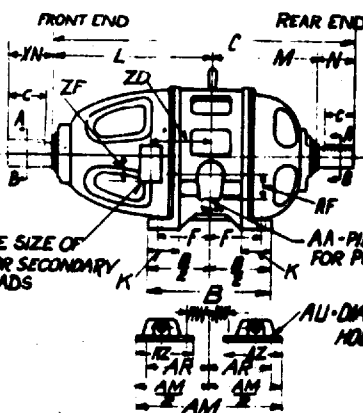
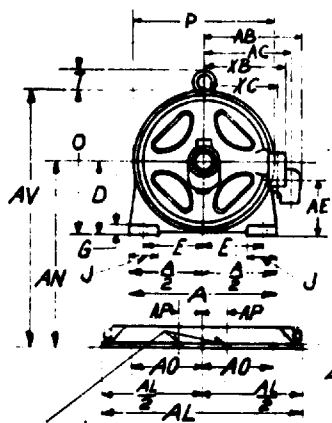
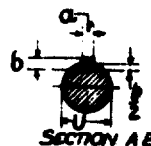
40 Degree

OUTLINE DIMENSIONS IN INCHES

2 DOWELS IN DIAGONALLY
OPPOSITE FEET WHEN
NECESSARY



TOP VIEW OF FOOT



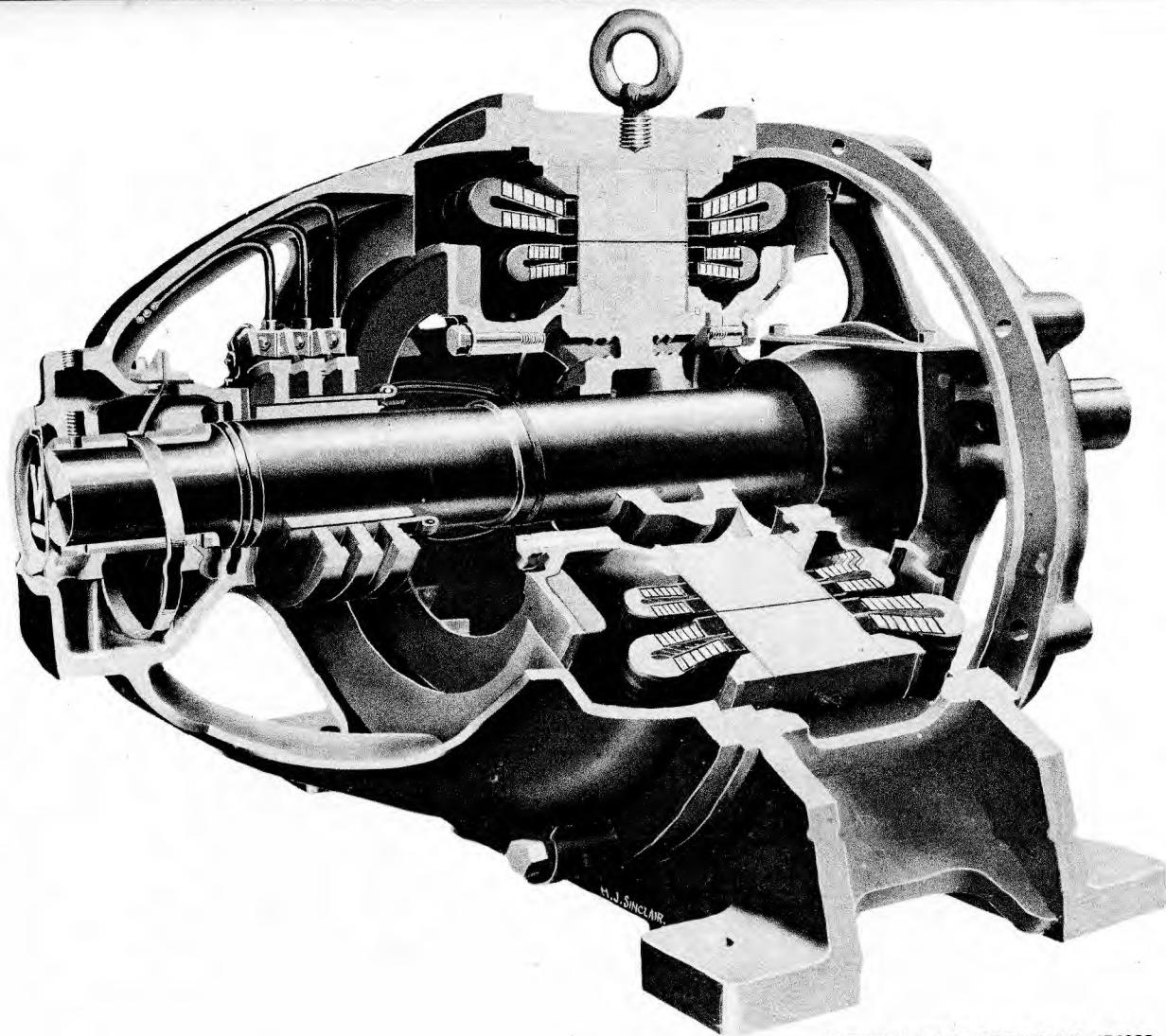
ZA - PIPE SIZE OF
CONDUIT FOR SECONDARY
LEADS

- AA-PIPE SIZE OF CONDUIT
FOR PRIMARY LEADS

THE USE OF FOUNDATION BOLTS IN CENTER HOLES IS NECESSARY FOR WALL & CEILING MOUNTING ONLY.

DIMENSIONS COMMON TO ALL FRAME NUMBERS OF EACH SERIES-INCHES																												
FRAME SERIES	A	D	E	G	H	J	K	N	O	P	T	X	N _{AL}	A _N	A _{OT}	CONDUIT 2A					CONDUIT 3A							
																2"	2 1/2"	3"	3 1/2"	4"	4 1/2"	5"	5 1/2"	6"	6 1/2"	7"	7 1/2"	8"
600	26 1/2	13	11	1 1/8	1 3/8	3 3/4	4 3/8	9	2 1/2	2 3/4	3 3/8	7 1/2	4 1/2	16 1/2	19 1/2	2 1/2	7	14	10	5	19	15	10	7	5 1/2	13 1/2	1 1/2	4
700	31	15 1/2	12 1/2	1 1/8	1 7/8	4 1/2	5 3/8	9 1/2	2 3/4	2 7/8	4 1/4	9	4 1/2	18 1/2	19 1/2	2 1/2	9	16 1/2	11 1/2	5	21 1/2	17 1/2	11 1/2	7	10 1/2	15	2	5 1/2
800	36 1/2	17 1/2	15 1/2	2	2 1/8	5 1/2	6 3/8	13	3 1/4	3 3/4	4 1/2	9 1/2	4 1/2	21 1/2	23 1/2	2 1/2	12 1/2	19 1/2	14	5	24	20	14	7	10 1/2	17 1/2	2	5 1/2

[illegible]



WESTINGHOUSE ELECTRIC PHOTO. 154288

CUTAWAY VIEW OF TYPE CW INDUCTION MOTOR

The entire layout of the plant is dependent on the location of the bins used for separating and storing the crushed stone. This location was definitely determined on the site selected for the plant. Soundings revealed that the overburden over the entire site ranged from two to three feet deep and by its removal the foundation could be placed on granite.

The output of the plant was calculated to be one hundred and eighty tons per day. Several sizes of bins were considered and it was decided that a bin with overall dimensions of twenty-four feet long by twelve feet wide by thirteen feet high divided into three equal sections would be best suited for the plant. Allowing one foot thickness in all directions for the walls, the approximate capacity of the bins is two hundred eighteen tons.

DEFINITIONS OF TERMS USED IN SPECIFICATIONS

Aggregate - Inert material which is mixed with portland cement and water to produce concrete. In general aggregate consists of sand, pebbles, gravel, crushed stone or similar materials. Aggregate is divided into two classes, namely: Fine aggregate, passing through a No. 4 sieve and Course aggregate, retained on a No. 4 sieve.

Concrete - A mixture of portland cement, fine aggregate, course aggregate and water.

Plain Concrete - Concrete without metal reinforcement.

Reinforced Concrete - Concrete in which metal is embedded in such a manner that the two material set together in resisting forces.

Mortar - A mixture of portland cement, fine aggregate and water.

Portland Cement - The product obtained by finely pulverizing clinker produced by calcinating to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials with no additions subsequent to calcination, excepting water and calcinated or uncalcinated gypsum.

Consistency - A general term used to designate the plasticity of freshly mixed concrete.

Flat Slab - A concrete slab having reinforcement bars extending in two or more directions without beams or girders to carry the load to supporting members.

Dead Load - The weight of permanent parts of the structure.

Live Load - Loads and forces other than dead load.

Deformed Bar - Reinforcement bar with shoulders, lugs, or projections formed integrally with bar during rolling.

Engineer - Engineer in responsible charge of work.

SPECIFICATIONS

Materials

Portland Cement - shall conform to the Standard specifications and tests for Portland Cement of the American Society for Testing Materials.

Fine Aggregate - shall consist of sand having clean, hard, strong, durable, uncoated grains and free from injurious amounts of dust, lumps, soft or flaky particles, shale or organic matter, loam or other deleterious substances.

Grading of Fine Aggregate

Passing No. 4 sieve - not less than 85%

Passing No. 50 sieve (not less than 10%
(not more than 30%)

Weight removed by decantation not more than 3%

Course Aggregate - shall consist of crushed stone having clean, hard, strong, durable uncoated particles, free from injurious amounts of soft, friable, thin, elongated or laminated pieces, alkali, organic or other deleterious matter. Size of Course Aggregate shall range from one-half to one and one-half inches.

Water - for concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances.

Metal Reinforcement - shall conform to the requirements of the Standard for Billet-steel concrete reinforcement bars of intermediate grade, made by the open-hearth process.

PROPORTIONING

The unit of measure shall be the cubic foot. One bag of ninety-four pounds of cement will be considered as one cubic foot. The mix shall be 1:2:4 (1 part cement, 2 parts fine aggregate and 4 parts course aggregate) throughout the entire structure.

Mixing - shall be done in a batch mixer of approved type. The mixing of each batch shall continue not less than one minute after all of the materials are in the mixer. The entire contents of the drum shall be discharged before re-charging.

DEPOSITING CONCRETE

Before depositing concrete, debris shall be removed from the space to be occupied by the concrete.

Concrete shall be handled from the mixer to the place of deposit as rapidly as practicable by a method which shall prevent separation or loss of ingredients.

Concrete, during, and immediately after, depositing shall be thoroughly compacted by means of suitable tools and by tapping forms opposite the freshly deposited concrete. The concrete shall be thoroughly worked around the reinforcement and into the corners of the forms.

Concrete shall be deposited continuously and as rapidly as practicable until the unit of operation is completed.

Under no circumstance shall concrete that has partially hardened be deposited in the work.

Concrete, when deposited, shall have a temperature of not less than 40 degrees Fahrenheit.

Before depositing new concrete on, or against, concrete which has set, the forms shall be retightened, the surfaces of the set concrete shall be roughened, thoroughly, cleaned of foreign matter and laitance, and saturated with water. The cleaned and saturated surfaces of the hardened concrete shall be slushed with a coating of neat cement grout against which the new concrete shall be placed before the grout has attained its initial set.

Exposed surfaces of concrete shall be protected from premature drying for a period of at least seven days after depositing.

FORMS

Forms shall conform to the shape, lines and dimensions of the concrete as called for on the plans. Lumber used in forms shall be dressed to a uniform thickness and shall be free from knots and other defects. Joints in forms shall be horizontal or vertical.

Forms shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape. Special care shall be used to prevent bulging.

Forms shall be thoroughly oiled before reinforcement is placed.

Bevels shall be in the angles of the forms to bevel the edges of the concrete.

Forms shall not be disturbed until the concrete has adequately hardened.

METAL REINFORCEMENT

Metal reinforcement, before being positioned, shall be thoroughly cleaned of mill and rust scale and of coatings that will destroy or reduce the bond.

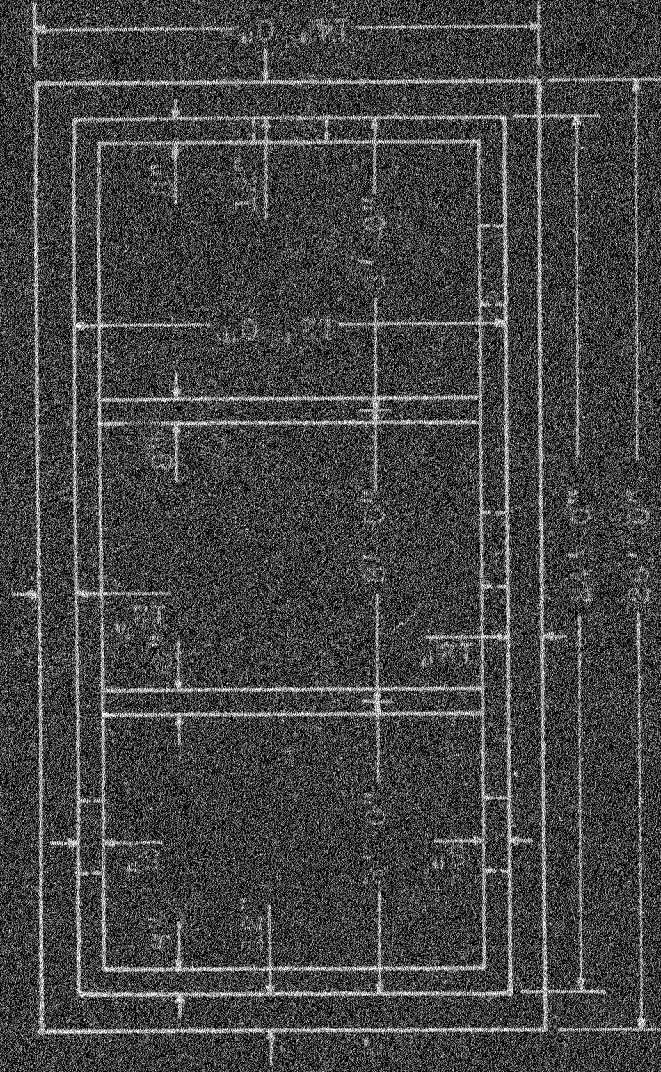
Metal reinforcement shall be accurately positioned and secured against displacement by using annealed iron wire of not less than No. 18 gage.

Bars shall have two inch covering of concrete.

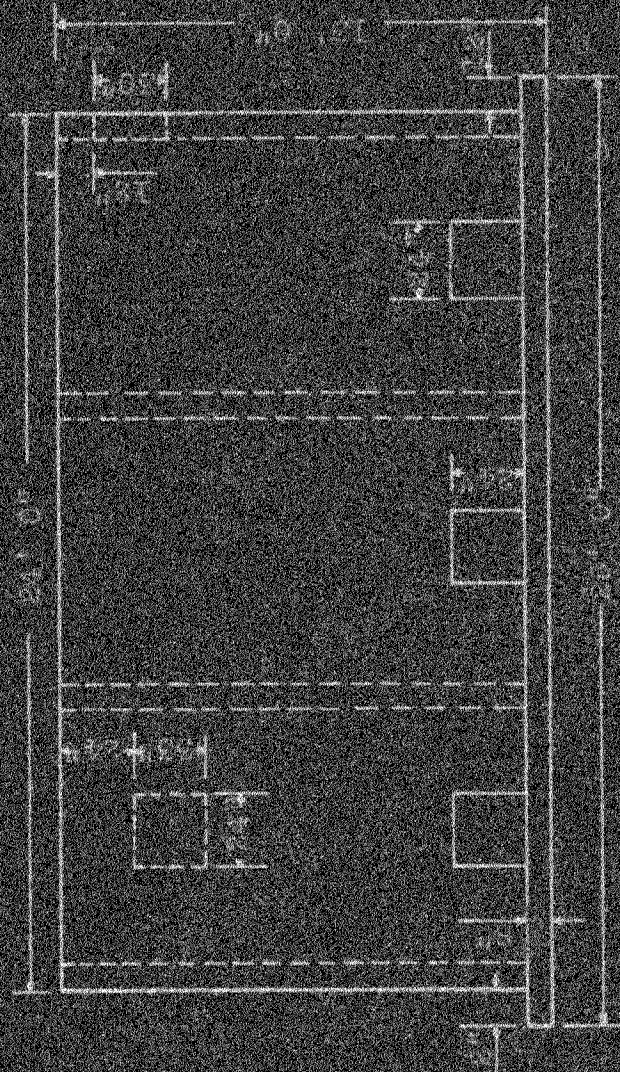
NOTATIONS USED IN DESIGN

- R - Reaction at supports due to loadings.
- M - Maximum bending moment in foot pounds.
- L - Clear span in feet.
- W - Uniformly distributed load per unit of length of beam.
- V - Total shear in pounds.
- v - Shearing unit stress.
- b - Width of rectangular beam.
- d - Depth from compression surface to center of reinforcement (effective depth)
- d' - Covering for steel added to d to give overall depth of beam.
- d_m - Effective depth by moment.
- d_s - Effective depth by shear.
- k - f_{spj}
- f_s - Tensile unit stress in longitudinal reinforcement.
- p - Ratio of effective area of tension reinforcement to effective area of concrete in beams.
- j - Ratio of lever arm of resisting couple to depth d .
- f_c - Compressive unit stress in extreme fiber of concrete.
- f_c' - Ultimate compressive strength of concrete at age of 28 days on tests of 6" x 12" cylinders.
- A_s - Effective cross sectional area of metal reinforcement in tension in beams.
- Z_o - Sum of perimeters of bars in one set.
- U - Bond stress per unit of area of surface of bar.
- L - Length in bond.

FLOOR



FLOOR



ELEVATION

DESIGN OF BINS

$$f_c' = 2000\# \text{ per sq. in.}$$

$$f_c = 800\# \text{ per sq. in.}$$

$$f_s = 18000\# \text{ per sq. in.}$$

$$n = 15 \quad v = 60 \quad k = 139 \quad j = 7/8 \quad U = 100$$

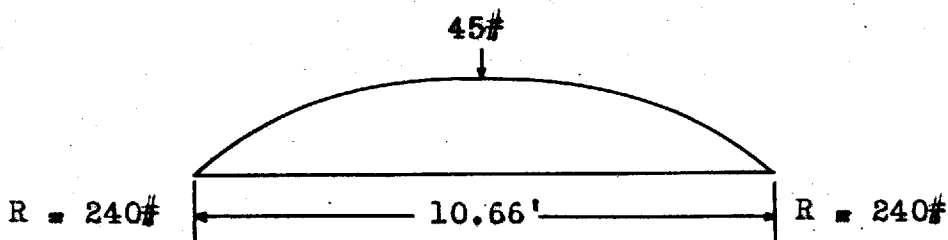
$$\text{Weight of crushed stone} = 150\# \text{ per cu ft.}$$

$$\text{Coefficient of fluidity} = 0.3$$

$$W = 150 \times 0.3 = 45\#$$

$$L = 10.66 \text{ ft.}$$

(Sketch)



$$R = \frac{(10.66)(45)}{2} = 240\#$$

$$M = \frac{1}{12} w l^2 = \frac{(45)(114)}{12} = 428 \text{ ft. lbs.}$$

$$V = 240\#$$

$$d_m = \frac{M(12)}{k} = \frac{(428)(12)}{139} = 6.08" \quad \text{use } d_m = 6"$$

$$d_s = \frac{V}{v_j} = \frac{(240)(8)}{(60)(7)} = 4.5"$$

$$d_m \text{ governs. Use } d \text{ as } 6" \quad d \text{ plus } d' = 8"$$

$$A_s = \frac{M(12)}{f_s j d} = \frac{(428)(12)(8)}{(18000)(7)(6)} = 0.054 \text{ sq. in.}$$

$$E_o = \frac{V}{u_j d} = \frac{(240)(8)}{(100)(7)(6)} = 0.457 \text{ in.}$$

As governs. 1/4 in. round bars spaced 12" center to center will be sufficient.

3/4 in. round bars were in the Company's warehouse and these were used instead of the 1/4 in. round. 1/2 in. round bars 12" center to center will be used.

$L = 4.5 D$ where $D =$ Bar size.

$$L = (45)(\frac{3}{4}) = 34"$$

The overall dimensions of the bins are 24' long, 12' wide and 13' high. The length of bars in the sidewalls will be 4" less than 24', or 23' 8" long, plus length in bond, 2' 10", a total of 26' 6". The height is 13', therefore 13 bars will be required in each side giving a total of 26 bars. Bars in end walls will be 4" less than 12', or 11' 8" plus length in bond, 2' 10", a total of 14' 6". The two end walls require 26 bars. The bars in the partitions will be hooked on the ends. The hooks will be bent on a 3" radius. They will be 12' 2" long and 26 bars will be required in the two partitions. This steel is $\frac{3}{4}"$ round. 102 bars in walls and 13 bars in slab will be required as temperature steel. This steel is $\frac{1}{2}"$ round.

SUMMARY OF STEEL

26' - $\frac{3}{4}"$ round bars - 26' 6" long - 689'	{	Tension Steel
26' - $\frac{3}{4}"$ round bars - 14' 6" long - 377'		
26' - $\frac{3}{4}"$ round bars - 12' 3" long - 318'		

Total 1384'

102 - $\frac{1}{2}"$ round bars - 12' 8" long - 1301'	{	Temperature Steel
13 - $\frac{1}{2}"$ round bars - 23' 8" long - 309'		

Total 1610'

Wt. of $\frac{3}{4}"$ round bar per ft. - 1.5#s

$$1384' \times 1.5\# = 2076\#s$$

Wt. of $\frac{1}{2}"$ round bars per ft. - 0.67#s

$$1610' \times 0.67\# = 1079\#s$$

Total 3155#s

The walls of the bins are 8" thick. The dimensions of the bins are 24' long by 12' wide by 13' high. The bottom slab is 8" thick, 26' long and 14' wide, and is to rest on a solid foundation and have a slope of 6" in order to drain.

SUMMARY OF CONCRETE

$2(24 \times 2/3 \times 12 \frac{1}{3}) = 394.7$ cu. ft. in two side walls

$4(10 \frac{2}{3} \times 2/3 \times 12 \frac{1}{3}) = 175.4$ cu. ft. in two end walls and two partitions.

$26' \times 2/3 \times 14' = 242.6$ cu. ft. in bottom slab.
Total 812.7 cu. ft. - 30.1 cu. yds.

CAPACITY OF BINS

Overall dimensions - 24' x 12' x 13'

Inside dimensions - 21' 4" x 10' 8" x 12' 4"

$(21.333 \times 10.666 \times 12.333)150$ - 210 Tons Capacity
 2000

In the introduction it is stated that the capacity of the bins will not quite take care of a day's run of 180 tons. The actual capacity of the bins is 210 tons, but the floor is flat and enough granite remains in the bins to prevent them from holding a full day's run. This was considered cheaper than building bins with a sloping floor and is a much stronger type of construction.

Openings for attaching the shutes shall be left in the wall facing the railroad track. The openings shall be at floor level and the floor under the openings shall be sloped 45 degrees for 8", the thickness of the walls. The openings are 2' 4" high and 2' 4" wide. They are to be located in the center of each section.

The opening for the sand shute shall be on the oppo-

site wall in the center of the section nearest the crusher. The excess sand is to be used in making a fill near the crusher and a temporary wood shute is to be used. The opening is to be 2' 0" wide and 2' 9" high and 2' 0" from the top of the bin.

UNLOADING SHUTES

The shutes are U shaped and in two sections. Both sections are 9" deep and 20" wide, and are made of No. 5 gage (3/8) sheet iron. The first section is attached to the bins at an angle of 45 degrees. The opening in the wall to receive this section is 24" x 24". The opening is to be framed with 2" x 8" timber. The timber being bolted to wall with $\frac{1}{2}$ " bolts. The section is attached to the wooden frame with $\frac{1}{2}$ " lag screws 3" long. This section is 2' 6" long and has a similar section inverted over it. Both ends of these sections are cut off at an angle of 45 degrees.

The second, or movable section, is 4' 8" long and is attached to the first section by an arrangement resembling a hinge and using a $\frac{3}{4}$ " bolt as a pin. The sides of the shute on the unloading end are rounded off on a 9" radius. To unload the bins the movable section is lowered. When raised it serves as a gate.

The shutes are operated with weights. A handle is attached to the discharge end. It is U shaped, inverted, of $\frac{1}{2}$ " round iron, and the ring at the top for attaching a rope or chain is 2" in diameter. It has a clearance of 13". A 4" pulley for each shute is bolted to a piece of timber 2" x 8" x 6', which in turn is bolted to the bins with three $\frac{3}{4}$ " bolts 6'

above the openings for the shutes. One inch hemp rope is used. When in position the weights are to be adjusted until the shutes and weights are balanced. Three shutes are required.

FOUNDATION FOR BINS

In selecting material for a foundation for the bins the natural choice was rubble masonry. More than enough stone for the foundation was already on the site.

Most building codes require that a masonry wall shall be not less than 20" thick. The foundation is to rest on solid granite, so walls 2' thick were considered sufficient. The foundation is 14' wide and 26' long, giving a foot clearance on all sides. A height of 17' above the granite is required to give sufficient clearance between the unloading shutes and the railroad cars.

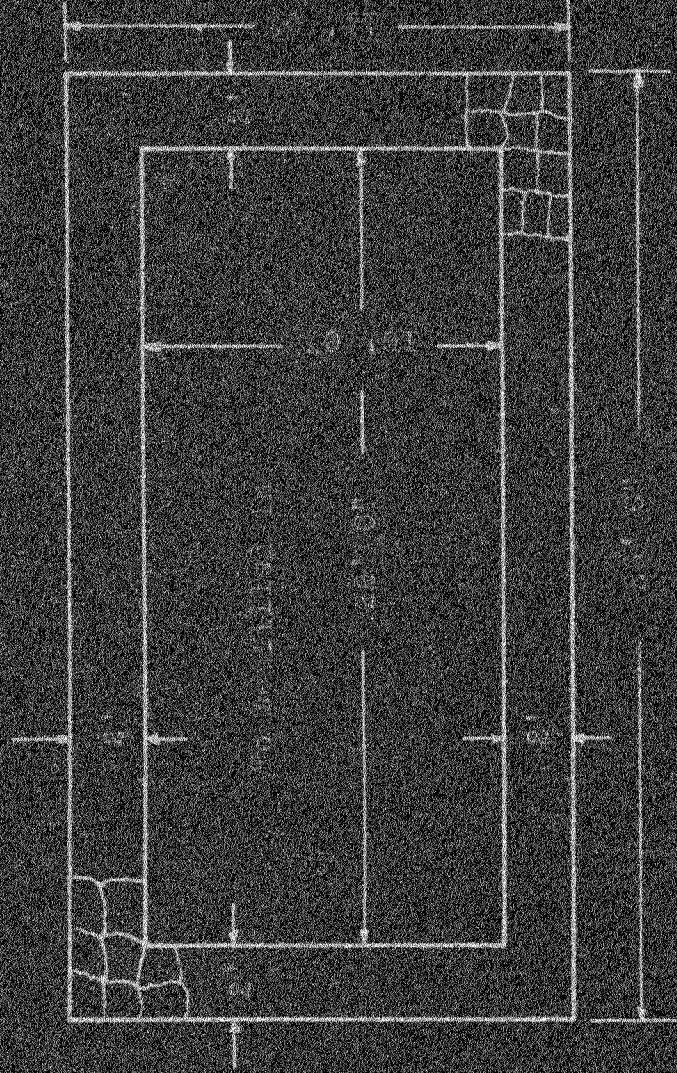
End Walls - $2(14' \times 17' \times 2')$ - 952 cu. ft.

Side Walls - $2(24' \times 17' \times 2')$ - 1732 cu. ft.

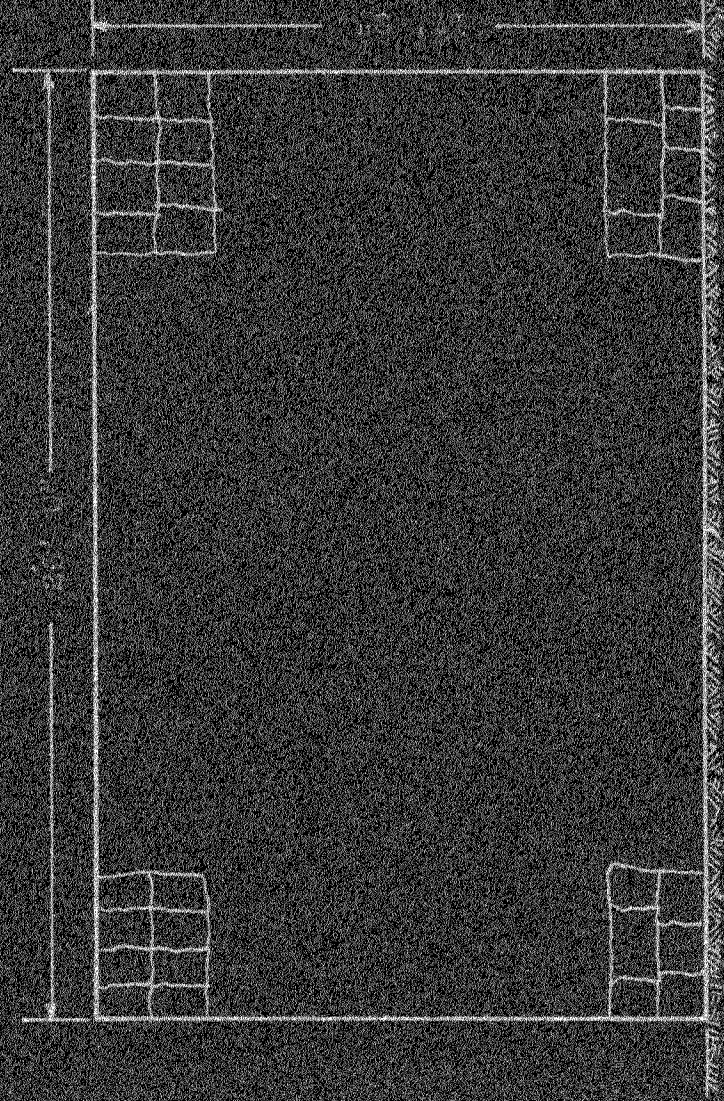
Total 2684 cu. ft. - 108 Perch

The hollow rectangle formed by the four walls is to be filled in with granite sand, overburden excavated for the foundation and small spawl. This filler was decided upon because a run way built on the quarry of this material had compacted to such an extent that it was difficult to penetrate it with a pick. The material was to be compacted by wetting and tamping and by being allowed to stand for several weeks.

STRAIGHT WALLS - FOUNDATION



PLAN



SECTION

CONVEYOR OR ELEVATOR

The problem of conveying the material from the crusher to the bins was next in line for consideration. The stone must be carried from the crusher to the screen, to be located on top of the bins, which separates it into three sizes and deposits it in the bins.

The location selected for the plant necessitated the use of an elevator type conveyor. The only practical elevator for a plant of this size is the bucket elevator. This consists of a series of buckets mounted on a continuous carrier. Two types of buckets are available. The Salem type to be used when it is necessary to pick the crushed rock up from a pile beneath the crusher and the continuous type bucket for loading directly from the crusher. The location and size of the plant made the use of the continuous type bucket most practical.

BUCKET

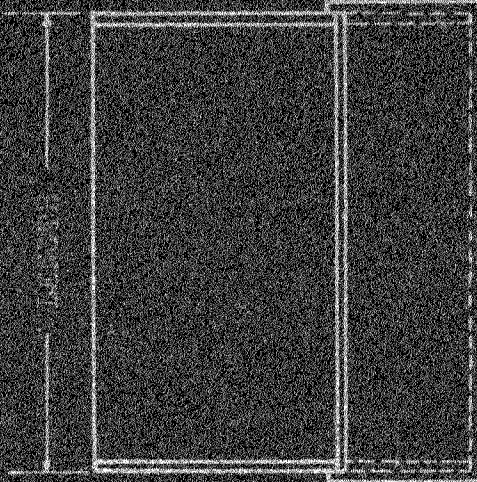
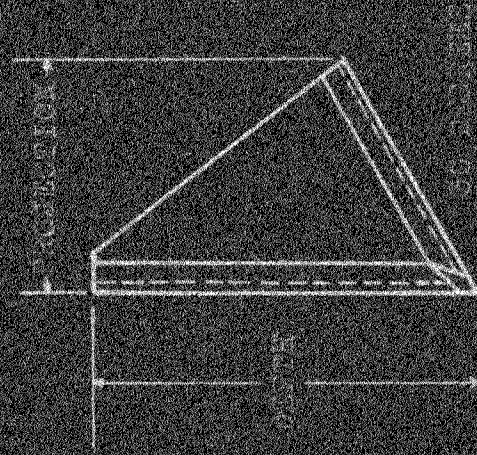
The bucket selected for installation is known commercially as a continuous steel elevator bucket, Style No. 1, manufactured by the Webster Manufacturing Company, 4500-4560 Cortland Street, Chicago, Illinois. This type of bucket is used for handling such materials as coal, stone, cement, ore, etc. It may be attached to either chain or elevator belt. The front can be made at an angle of 30 or 40 degrees with the horizontal. An angle of 30 degrees will be used because the elevator is to be set at an angle with the vertical.

Specifications & Dimensions

Size - 12" x 6"

Length - 12"

CONSTRUCTION OF MODEL



MODEL SIZE
12.5 x 50.0

12.5 x 50.0

MODEL

12.5

MODEL SIZE

12.5

MODEL

12.5

MODEL SIZE
12.5 x 50.0

12.5

MODEL

12.5

MODEL

12.5

Projection - 6"

Depth - 11 3/4"

Gauge - 12

Weight - 13.40 #s

Angle with horizontal - 30 Degrees

Capacity - 0.236 cu. ft.

CARRIER

Two types of continuous carriers are available: Belt type and Chain type. After a careful investigation of the two types and upon the recommendations of the crusher manufacturer and crusher operators, the chain type was selected.

The chain is known commercially as a combination chain and is also made by the Webster Manufacturing Company. It is a very simple, strong, durable and easily repaired chain, made up of malleable block links alternating with steel side bars. It is used extensively for elevating and conveying service handling gritty materials.

The close-fitting joints in the combination chain tend to keep out particles of the abrasive material being handled by the chain and to a considerable extent prevent wear from this source. The large wearing surfaces further reduce the effective wear, making the chain especially desirable for all situations where gritty material is handled and an inexpensive chain is required.

The combination chain is made up of malleable iron links, connected by steel side bars and steel pins. The pins are of the detachable type provided with cotters.

Owing to the nature of its construction, this type of chain is well suited for handling stone, cement, gravel and other abrasive materials.

The pins are milled flat on the end and are accurately fitted into correspondingly shaped holes in the steel side bars.

This construction prevents the pins from turning in the side bars and confines the wear to that part of the pin inside the long barrel of the malleable link, where it is distributed over a large area, thus insuring minimum elongation of pitch and maximum durability of the chain.

The cast links are made of highest grade malleable iron smoothly cored for a close fit over the pins. By use of special pattern equipment and tools, accuracy of pitch is assured and clearance between all wearing surfaces reduced to a minimum.

Specifications

Chain - No. 102B

Pitch - 4"

Approximate links in 10' - 30

Approximate weight per 100' - 600#s

Average ultimate strength - 24000#s

The attachment links for attaching the buckets to the chain are cast links. They have flanges extending at right angles to the side bars with two $3/8$ " holes in each flange for bolting the buckets on.

The bucket chain runs on heavy friction discs 18" in diameter mounted on 2 $15/16$ " shafts. This type of drive is thoroughly dependable and highly satisfactory in every way.

The friction drive acts as a safety device in case the bucket, or bucket chain, are accidentally caught.

The bearing boxes are of steel, babbitt lined, and adjustable for taking up normal wear in drive.

Rollers 6" in diameter and 10" long are to be placed on the frame 4'6" center to center to support the chain when the buckets are loaded. The rollers are mounted on 1" shafts and have two bearings.

It is important to have the proper tension on the bucket chain at all times. Heavy steel take-ups are placed at the bottom of the elevator where they are subjected to the least strain and where they may be easily and quickly adjusted.

LAY-OUT OF ELEVATOR

Elevators using 30 degree buckets should be set at an angle of 30 degrees with the vertical to operate at maximum efficiency. The vertical distance from the discharge end of the crusher to the top shaft of the elevator is 39 ft. Setting the elevator at an angle of 30 degrees gives a distance of 45 ft. from center to center of shafts.

The actual length of chain is $2(45)$ plus circumference of one friction disc. This distance is $94' 8\frac{1}{2}"$. Allowing $2' 3\frac{1}{2}"$ for slack the total length of the chain is 97 ft. A bucket and its clearance occupies one foot of chain. Ninety-seven buckets are required.

Ten rollers 6" in diameter and 10" long spaced at 4' 6" center to center are required.

The frame is to be made of 3" x 10" timbers and resembles a ladder in construction. It is 46' long. Struts, or

stiffeners 1' 4" long spaced 4' 6" center to center are required. Eleven of these will be used. The frame is to be supported at the quarter points. Two sets of the supports will be attached to the bins and one set rests on concrete foundations placed on solid granite. Two pieces of 3" x 10" timber 10' long are to be bolted to the bins with $\frac{3}{4}$ " bolts and the supports are to be bolted to these timbers. One piece of timber is to be placed 2' 6" below the top of the bins and the other at the bottom of the bins and resting on the projection of the foundation. Length of support nearest top of bins is 4' 0". Length of other support is 9' 6". Length of support resting on foundation is 8' 0".

The supports resting on the bins consists of a 3" x 10" timber under each side of the frame extending directly back to the bins and a timber extending from each side of the frame to the ends of the timber bolted to the bins. This type of construction supports the elevator directly and provides sway bracing. The supports resting on concrete foundations have no sway bracing.

The shaft at the lower end of the elevator is 2' 0" long and is of 2" axel steel. The shaft at the top carries the gears for the screen as well as the elevator. It is 6' 0" long and is also of 2" axel steel.

The elevator is belt driven. A shaft is to be placed on the frame below the main shaft. This shaft is 6' long and is of 2" axel steel. A 30" pulley to take an 8" belt is on one end and a gear with fifteen teeth is on the other end. The small gear turns a large gear of 75 teeth on the main shaft.

SPEED OF OPERATION OF BUCKET CHAIN

The superintendent, from long experience in quarry operation, requested a rate of travel for the bucket chain of between 80 and 90 feet per minute. This was to take care of possible over run of production of the crusher. Small material passes through the crusher very rapidly and occasionally a soft strata of granite is struck. If the buckets were unable to remove the product of the crusher as fast as it was produced the plant would be compelled to suspend operations.

An R. P. M. of 90.2 for the 30" pulley driving the bucket chain will give a rate of 85' per minute. This was considered satisfactory. Power is transmitted from the crusher to the elevator and screen. The calculated R. P. M. of the crusher is 193.3. Power is transmitted from it by a 30" pulley.

Crusher - 36" pulley R. P. M. 193.3

Elevator - 30" pulley R. P. M. 90.2

It will be necessary to install a countershaft to reduce the R. P. M. of the crusher to the R. P. M. of the elevator.

COUNTERSHAFT

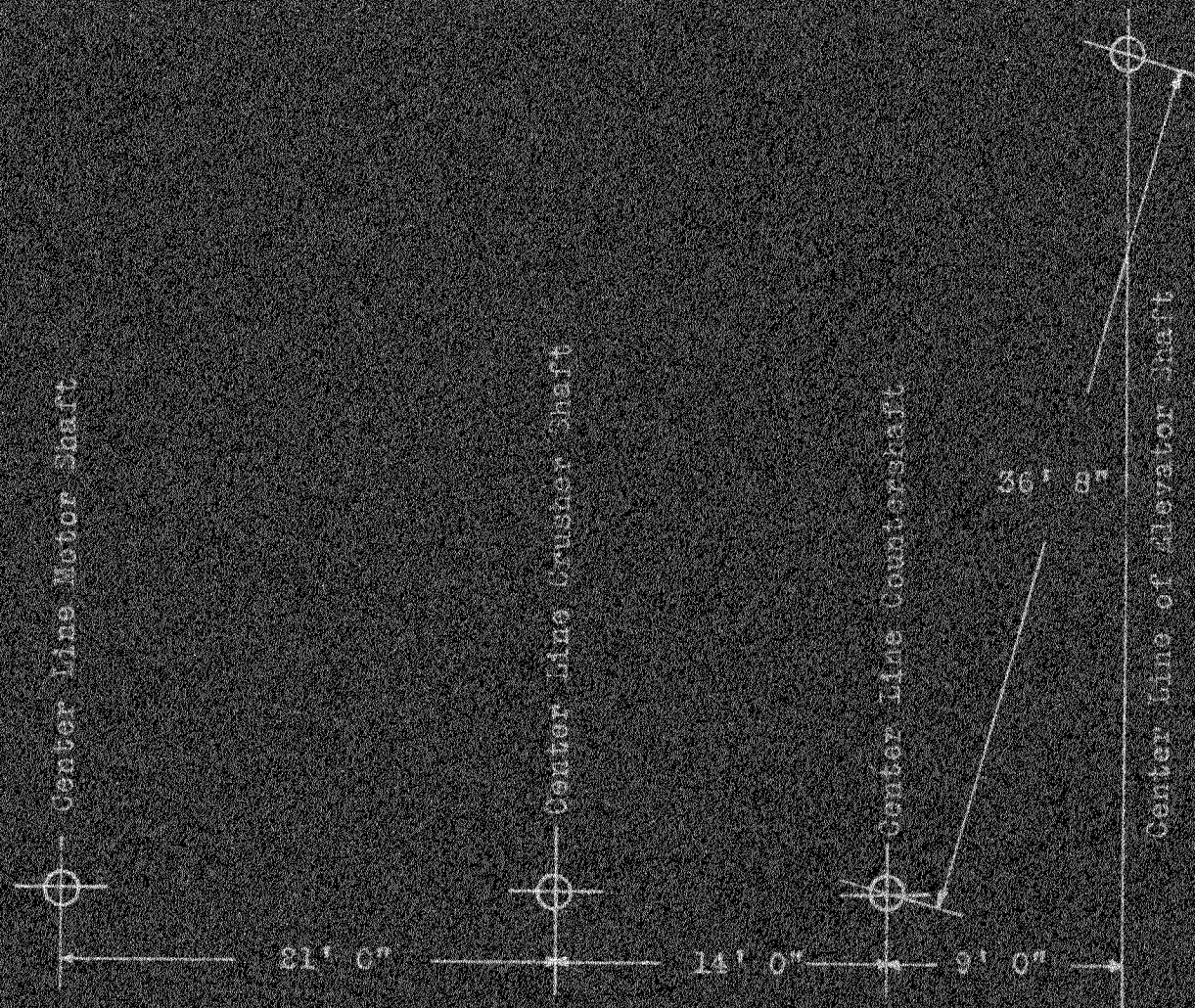
The Countershaft shall be of 2 5/8" axel steel and shall be 8' long. A 36" pulley for power from the crusher and a 14" pulley for power to the elevator will make the necessary adjustment in speeds. A heavy shaft is used because power is not transmitted in line. The shaft will have two adjustable, steel, babbitt lined, bearings and will rest on concrete foundations.

GENERAL LAYOUT OF PLANT

The general layout of the plant is based on the location of the bins. The placing of the crusher is dependent on the angle of operation of the elevator. The horizontal distance from the center of the shaft of the elevator on top of the bins to center of shaft of crusher is 24' 6". The countershaft is located 14' 0" from the crusher center to center of shafts. The distance from the foundations of the bins to the center of shaft of countershaft is 8' 0". These distances are necessary to give proper clearance. The distance from the center of shaft of motor to the center of shaft of the crusher is 21'. The distance is necessary to give room for a house for motor and loading platform for the crusher. The distance from the foundation of bins to wall of power house is 37' 0". The house for the motor is to be 12' 0" x 13' 0" overall and of concrete. The walls are to be 8" thick and 8' high.

A special feature of the design of this plant is the elimination of mechanical feeders for the crusher. A ramp is to be built so the trucks can dump directly on the loading platform or on the ramp near the platform. This necessitates a retaining wall 37' 0" long and 17' 0" high and a small fill.

The total overall length of the plant is 76' 0" and the width is 14' 0".



LAYOUT AND POWER DISTRIBUTION OF PLANT

POWER HOUSE

The overall dimensions of the power house are 13' long and 12' wide. The walls are to be 8' high, 8" thick and of 1:2:4 mix concrete.

Three openings will be made in the walls. Two openings 3' 6" wide and 6' 2" from the floor. One will be used as a door and will be 3' 3" from the wall next to ramp. One will have the same dimensions and the belt from the motor to the crusher will pass through it. It will be located in the center of the wall. One opening will be a window 2' 6" wide and 4' 4" high. The window will be 2' 3" from the floor. The window and door will be left open when the motor is running to keep it cool.

The door and window frames will be of 3" x 8" timber.

The floor will be 8" thick and of 1:2:4 mix. A layer of tar paper or elastite will be placed between the floor and the motor foundation. This will serve as an expansion joint and eliminate vibration.

The rafters and struts of the roof frame shall be of 2" x 4" timbers. The pitch shall be 0.2. The covering shall be of 1" x 8" tongue and groove board covered with a good grade of tar paper.

Concrete:

Walls - $2(13' \times 8' \times 0.667')$ = 138.736 cu. ft.

$2(10.667' \times 8' \times 0.667')$ = 128.068 cu. ft.

Total 266.804 cu. ft.

Openings - $2(3.5' \times 6.167' \times 0.667') = 28.793 \text{ cu. ft.}$

$2.5' \times 4.333' \times 0.667' = 7.225 \text{ cu. ft.}$

Total 36.018 cu. ft.

Total cu. ft. concrete in walls is 266,804 cu. ft. less
36.018 cu. ft. which gives 230.786 cu. ft.

Floor:

$13' \times 12' \times 0.667' = 104.052 \text{ cu. ft.}$

Summary of concrete:

Walls - 230.786 cu. ft.

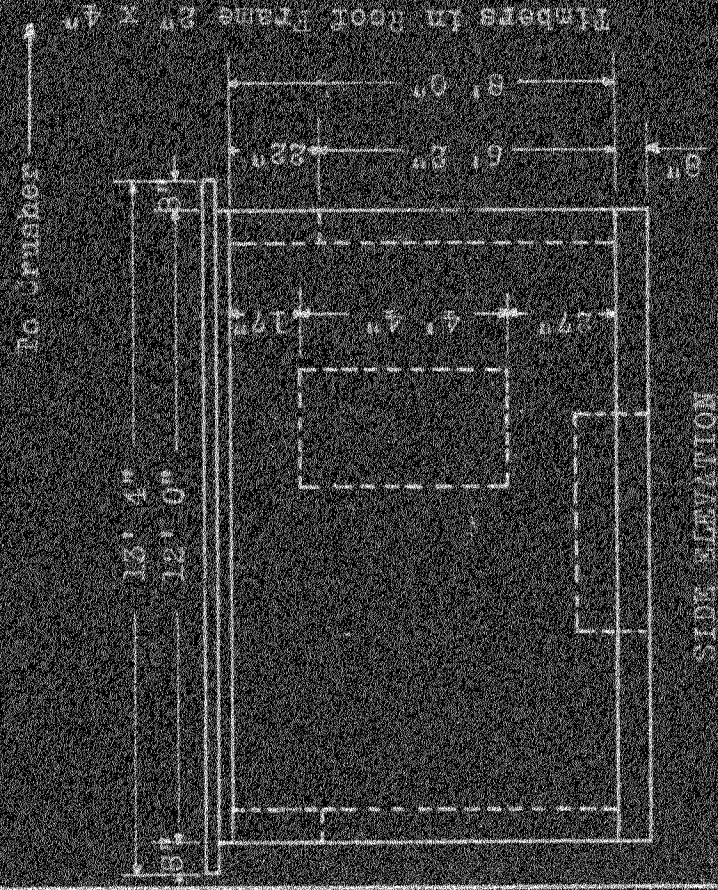
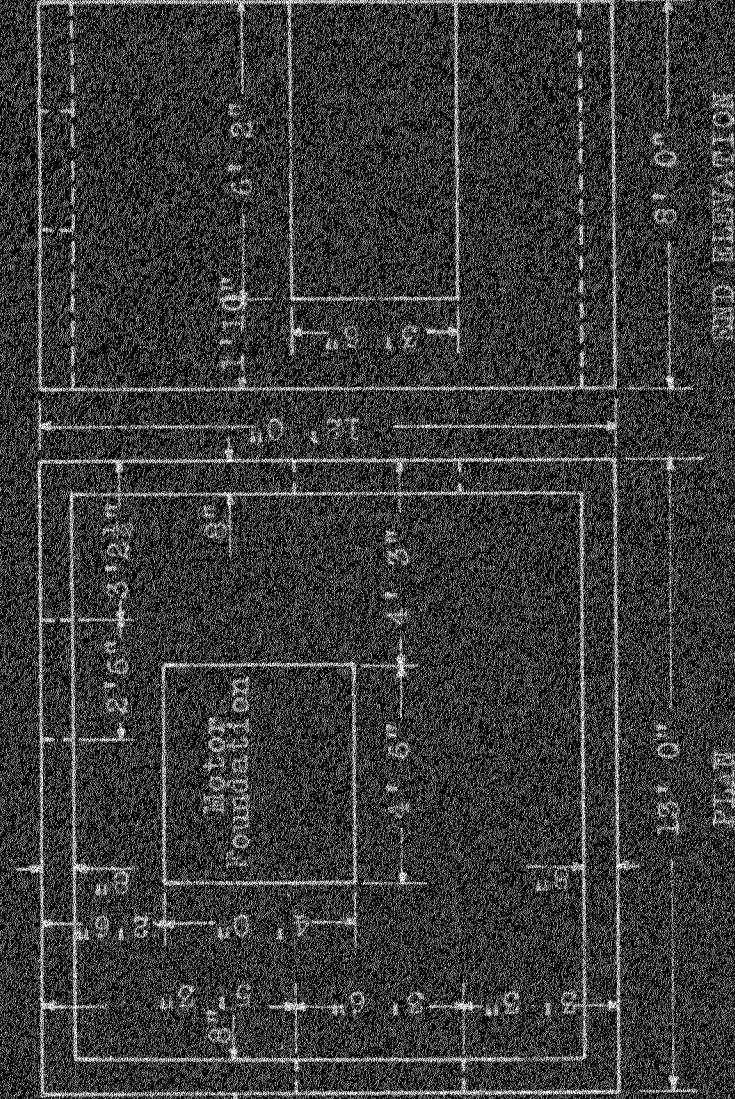
Floor - 104.052 cu. ft.

Total 334.838 cu. ft. or 12.401 cu. yd. concrete

There is a supply of old $\frac{3}{4}$ " and 1" pipe on the quarry that the superintendent wished to get rid of. This was placed in the walls and floor 12" center to center as reinforcement.

The door and window are to be built of the same material the roof is covered with. The door is to swing in and the window out.

MOTOR HOUSE



TO CRUSHER

Timbers in Roof Frame 2" x 4"

CONCRETE FOUNDATIONS

All concrete foundations are to be made of 1:2:4 concrete.

MOTOR

The foundation for the motor is to be 4' 6" long, 4' 0" side, 1' 6" deep and rests on solid granite.

To keep down vibration and to cushion the motor 2 pieces of 3" x 10" timbers 4' 0" long are to be bolted to the foundation with five 5/8" bolts, each set in the concrete and the motor bed is to be bolted to the timbers with eight 5/8" bolts.

The motor is on an adjustable bed so the belt may be kept at the right tension all of the time.

4.0' x 4.5' x 1.5' = 27 cu. ft. or 1 cu. yd.

CRUSHER

The foundation for the crusher is two section. One section supporting each side. There is a 4' 0" space between the two for the elevator. The crusher is cushioned by the use of one piece of timber 4" x 10" , 7' 4" long and one piece of 3" x 10" timber 6' 4" long on each section of foundation. The timbers are bolted to the concrete with three 3/4" bolts per section set in concrete. The crusher is bolted to the timber with two 3/4" bolts per section.

2(4' x 9' x 2.25') = 81 cu. ft. or 3 cu. yd concrete.

COUNTERSHAFT

The foundation for the countershaft is in two sections. One section to support each bearing. The countershaft

is cushioned by using one piece of 3" x 10" timber 18" long on each section. The timber is bolted to the concrete with four 5/8" bolts, set in the concrete. The bearings are bolted to the timber with four $\frac{1}{2}$ " bolts each.

$2(2.25' \times 4' \times 0.667') = 12.000 \text{ cu. ft. or } 0.444 \text{ cu. yd. concrete.}$

LOADING PLATFORM

The platform is supported by six 8" x 8" timbers. Two of these timbers rest on concrete projections from pilasters. The other four rest on concrete foundations. These foundations are seated on solid rock. A square hole 4" deep and large enough to receive the 8" x 8" timbers are to be left in the top of the foundations.

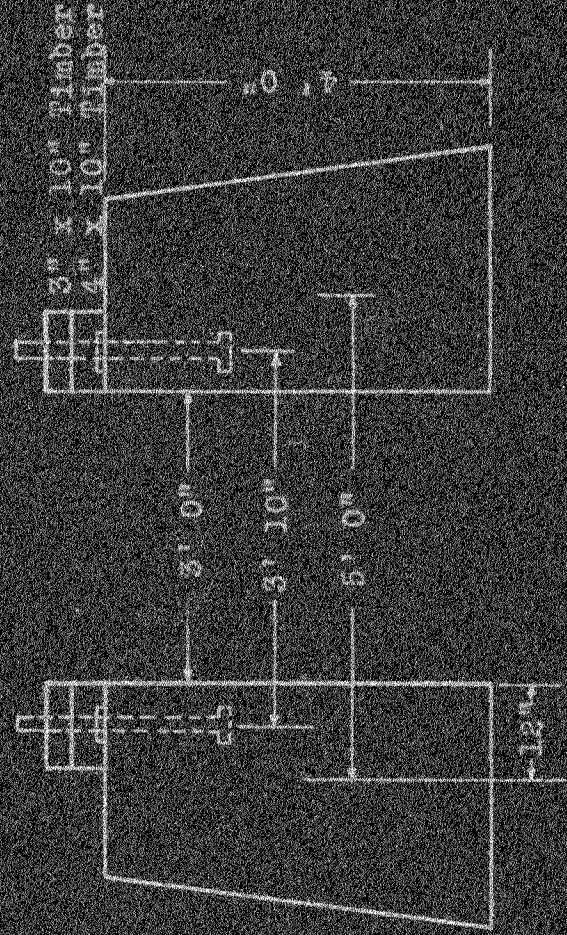
$4(1.75' \times 1.75' \times 2') = 24.500 \text{ cu. ft. or } 0.907 \text{ cu. yd. concrete.}$

ELEVATOR

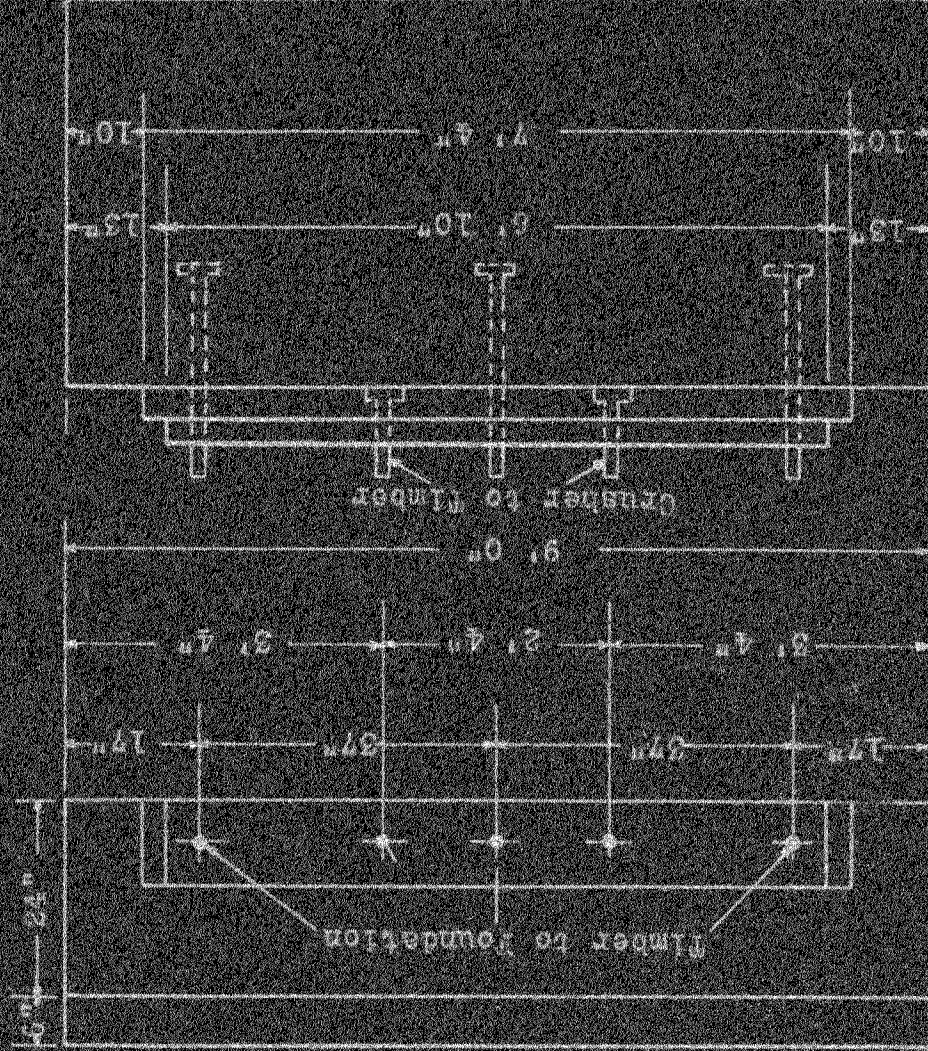
The foundations for the elevator are seated on solid granite. They are 2' 0" x 2' 0" on top and 3' 0" x 3' 0" at the bottom and 2' 6" deep. Slots 4" deep and enough to take the 3" x 10" timber will be left in the top of the foundation.

$2(2.5 \times 2.5 \times 2.5) = 31.250 \text{ cu. ft. or } 1.158 \text{ cu. yd.}$

CRUSHER FOUNDATIONS



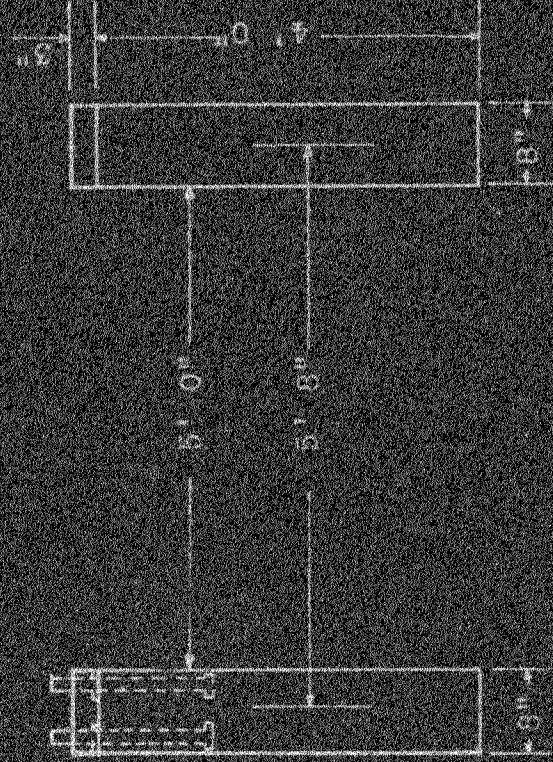
ELEVATION



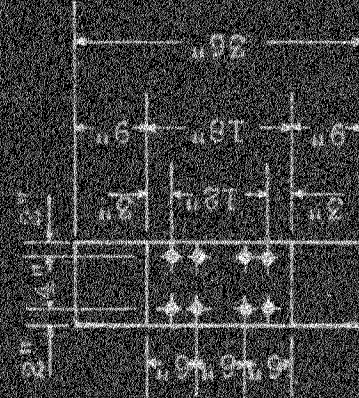
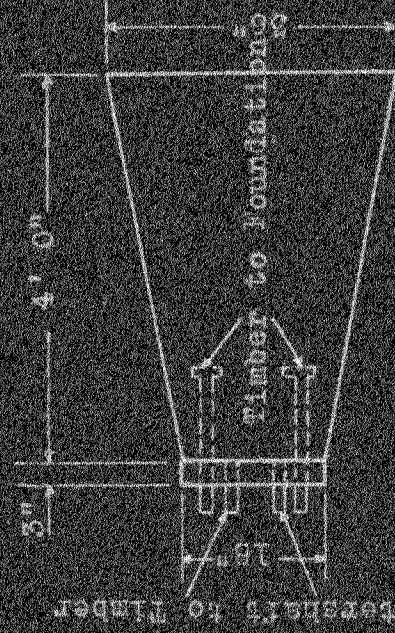
PLAN

ELEVATION

COUNT THESE WOUND-UP



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BELTS

All belts are to be of friction surface rubber belting, of 32 oz. duck construction, manufactured by the B. F. Goodrich Rubber Company of Akron, Ohio. The main drive belt is to be 10" wide and 5 ply. All other belts are to be 8" wide and 4 ply.

MAIN DRIVE - MOTOR TO CRUSHER

It is 21' 0" from center of shaft of the motor to center of shaft of the crusher. The motor pulley is 8" in diameter and the crusher 36". A 10" 5 ply continuous belt will be used.

Length of belt

$$2(21) \text{ plus } \frac{2.094}{2} \text{ plus } \frac{9.425}{2} = 47.76' \text{ Length of 10" belt } 47'10"$$

CRUSHER TO COUNTERSHAFT

The distance from center of shaft of crusher to center of shaft of countershaft is 14' 0". The crusher pulley is 36" in diameter and the countershaft pulley 40". An 8" 4 ply belt will be used.

Length of belt

$$2(14) \text{ plus } \frac{9.425}{2} \text{ plus } \frac{10.472}{2} = 37.949' \text{ Length of 8" belt } 38'0"$$

COUNTERSHAFT TO ELEVATOR

The distance from center of shaft of countershaft to center of shaft of elevator is 36.623'. The countershaft pulley is 14" in diameter and the elevator pulley is 30". An 8" 4 ply belt will be used.

Length of belt

$$2(36.623) \text{ plus } \frac{3.665}{2} \text{ plus } \frac{7.854}{2} = 79.006' \text{ Length of 8" belt } 79'0"$$

Total length of 10" belt used = 47' 10"

Total length of 8" belt used = 117' 0"

RETAINING WALL

The retaining wall will be designed as a cantilever retaining wall with pilasters. Two pilasters are to be constructed of concrete and are to be used as supports for one end of the loading platform. One end wall of the rubble masonry foundation of the bins will function as a pilaster and so will the end wall of the motor house. The pilasters will be on the back of the wall. This will put the entire structure in compression and no tension reinforcement will be required. The wall is to be 37' 0" long. The distance from the bins to the center line of the first concrete pilaster is 14' 7". The distance center line to center line of the concrete pilasters is 11' 10". The distance from the second concrete pilaster to the motor house is 10' 7". This layout takes care of the loading platform.

The same specifications used in the design of the bins are to be used here. The same notations are to be used with the following additional.

ϕ - Angle of repose of fill

C_e - Coefficient of fluidity of material in fill

B - Base of retaining wall

H - Height of wall

$\frac{B}{h}$ - Ratio of base to height

h' - Surcharge

h - Height of wall plus surcharge

w - Weight of fill per cubic foot

The wall will be designed with a 20 ton truck on the fill. The weight of the truck will be reduced to an

equivalent surcharge and added to the height of the wall to get the height on which the wall will be designed.

The wheels of the truck will strike a timber ramp at a point 2' 0" from the wall. The wheels of the truck will be placed at this point and the equivalent surcharge calculated.

The distribution of the pressure exerted by the truck takes the form of a wedge 6' 0" across the pointed side. The base of the wedge will be a rectangle.

Design of wall:

The weight carries on the two rear truck wheels is 16,000#s per wheel, or 32,000#s for the two wheels. The sharp edge of the wedge is 6' 0". The sides of the wedge will slope at an angle of 30 degrees. It will strike the wall 1.732' from the top. The rectangular base of the wedge will be 4' x 10', an area of 40 square feet.

$$\frac{32000}{40} = 800\#s \text{ equivalent surcharge in pounds}$$

The weight of the fill is 150#s per cu. ft.

$$\theta = 30 \text{ degrees}$$

$$C_e = 0.3$$

$$H = 17'$$

$$\frac{B}{h} = .42$$

$$B = .42(17) = 7.14'$$

$$h' = 5.333'$$

$$h = H \text{ plus } h' = 17 \text{ plus } 5.333 = 22.333'$$

$$b = 12"$$

$$v = 40$$

$$j = 7/8$$

Since there is no tension the design will be made for shear.

$$V = Cew \frac{h^2}{2} \cos \theta$$

$$V = (0.3)(150)(249.4)(.866)$$

$$V = 9720$$

$$d = \frac{V}{vjb}$$

$$d = \frac{(9720)(8)}{(7)(40)(12)}$$

Use d as 24" at bottom of wall. The top of the wall will be 10" thick.

The pilasters will be 18" thick and 33" deep to a point 7' from the bottom. At this point they will be 50" deep. This design will be necessary to take care of the loading platform and to provide sufficient depth at the bottom of the wall. The wall, pilasters and one side of the crusher foundation will be poured at one time and the pilasters and crusher foundation will be tied together.

Test for stability:

P_v will be the force acting in the vertical direction and will be the vertical component of the force diagram. P_v is equal to the weight of the fill resting directly on the wall plus the weight of the wall plus the weight of the pilaster and projection plus the weight of the crusher foundation all calculated for a section 12" wide.

Weight of fill and wall
 $(22.333)(2)(1)(150) = 6700\#s$

Weight of pilaster
 $(16)(2.75)(1)(150) = 6600\#s$

Weight of pilaster projection
 $(7)(1.417)(1)(150) = 1488\#s$

Weight of crusher foundation
 $(4)(2.25)(1)(150) = 1500\#s$
Total 16288#s

$$P_v = 16288\#s$$

P_h will be the force acting in the horizontal direction and is equal to $Cw\frac{h^2}{2}$

$$P_h = Cw\frac{h^2}{2}$$

$$P_h = 11,233\#s$$

The force diagram is plotted with P_h acting at a point on the wall one third of its height from the base of the wall. The resultant of the two forces acting is the hypotenuse of a right triangle of which P_v is one leg and P_h the other. It passes through the middle third of the base of the wall and therefore the wall is stable. All forces acting on it are in equilibrium.

Concrete:

Wall

$$(1.417)(17)(37) - 891.293 \text{ cu. ft.}$$

Pilasters

$$2(2.75)(1.5)(16) - 132.000 \text{ cu. ft.}$$

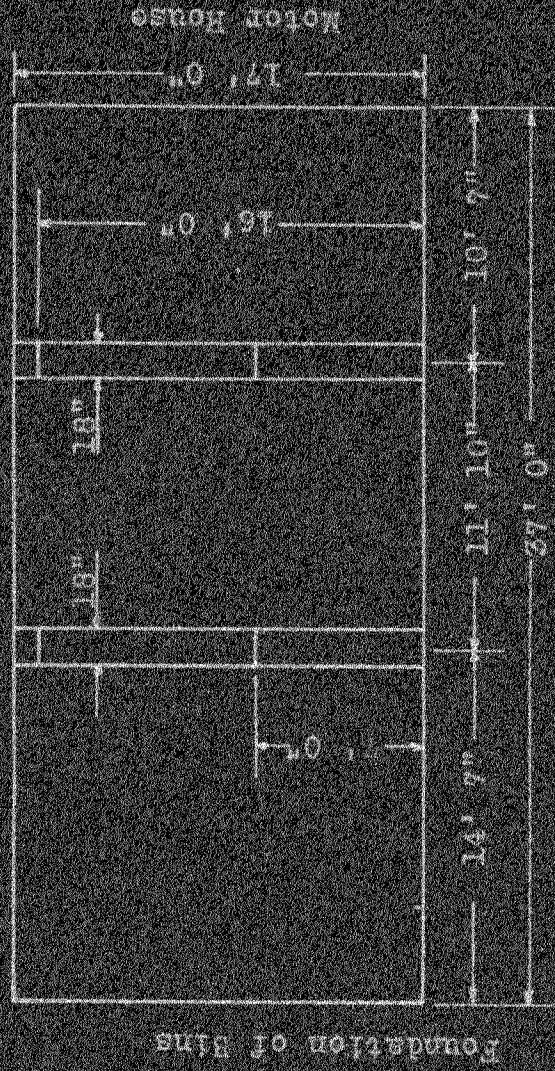
Projections

$$2(1.417)(1.5)(7) - 29,357 \text{ cu. ft.}$$

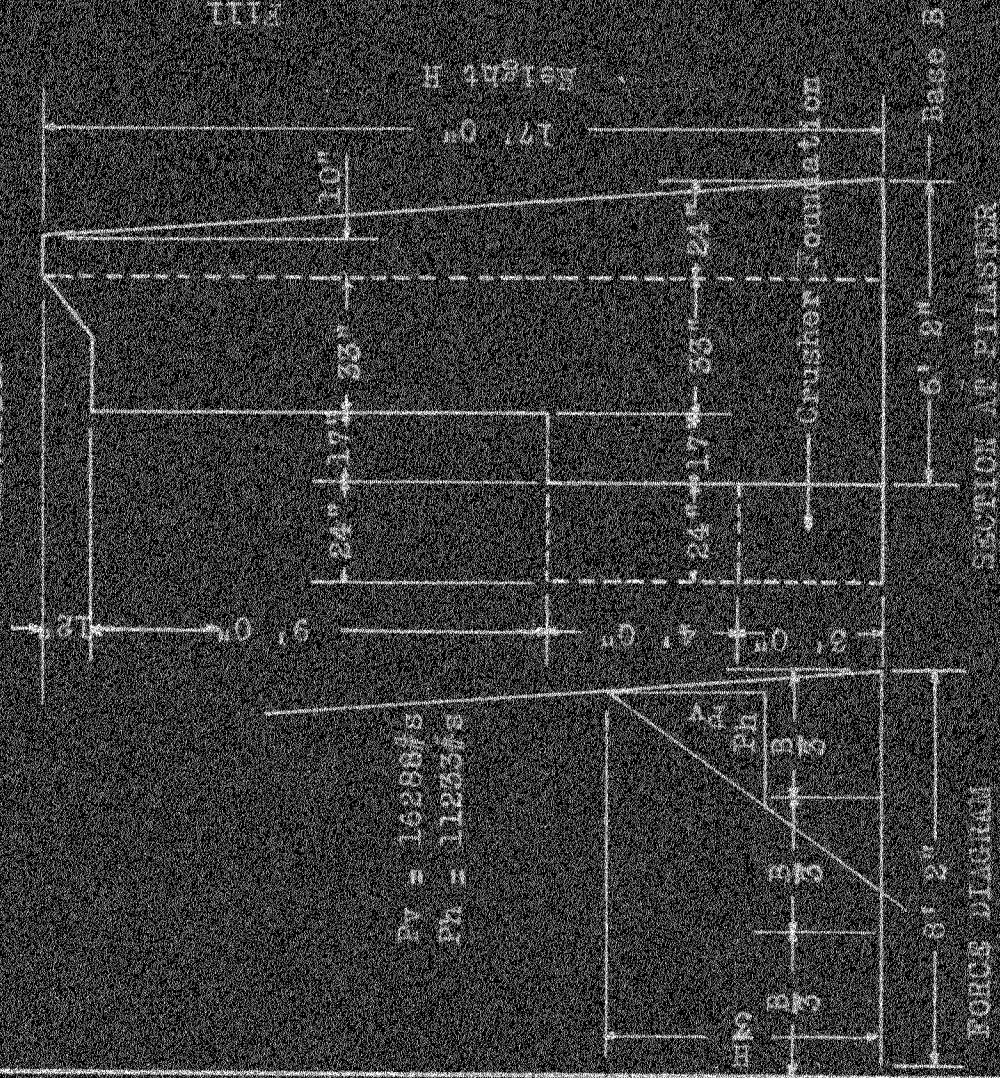
Total

$$1052.650 \text{ cu. ft. or } 38.987 \text{ cu.yd.}$$

RETAINING WALL



ELEVATION



LOADING PLATFORM

A loading platform 12' x 14' is large enough for the crew to work on and to hold enough stone to keep a constant supply going into the crusher.

The floor will be constructed of 3" x 10" timbers 18' 4" long. A rail of 8" x 8" timbers will be placed on three sides of the floor. No rail will be placed on the side facing the ramp. The 14' dimension of the platform is parallel to the bins and at right angles with the retaining wall. The flooring will extend to a point approximately 5' 6" from the retaining wall and 1" space will be allowed between the timbers. A piece of 8" x 8" timber 14' 0" long will be placed on top of the retaining wall. 3" x 10" timber will extend from this timber to floor of the platform making a sloping ramp for the stone to roll down to the crusher mouth. The slope is 1' 0" in 6' 2". The ramp is to be supported by one piece of 8" x 8" timber resting on top of the pilasters and is to be covered with sheet iron. The floor will be constructed on 3" x 10" stringers 2' 9" center to center. The ends of the floor will rest on 8" x 8" timbers. It will be necessary to place a piece of 2" x 10" under the 8" x 8" timbers to bring them to the same elevation as the 3" x 10" stringers. The 8" x 8" timber will extend to the pilasters and the stringers will extend to the retaining wall. They will be tied to the 8" x 8" support of the ramp with 2" x 4" timbers.

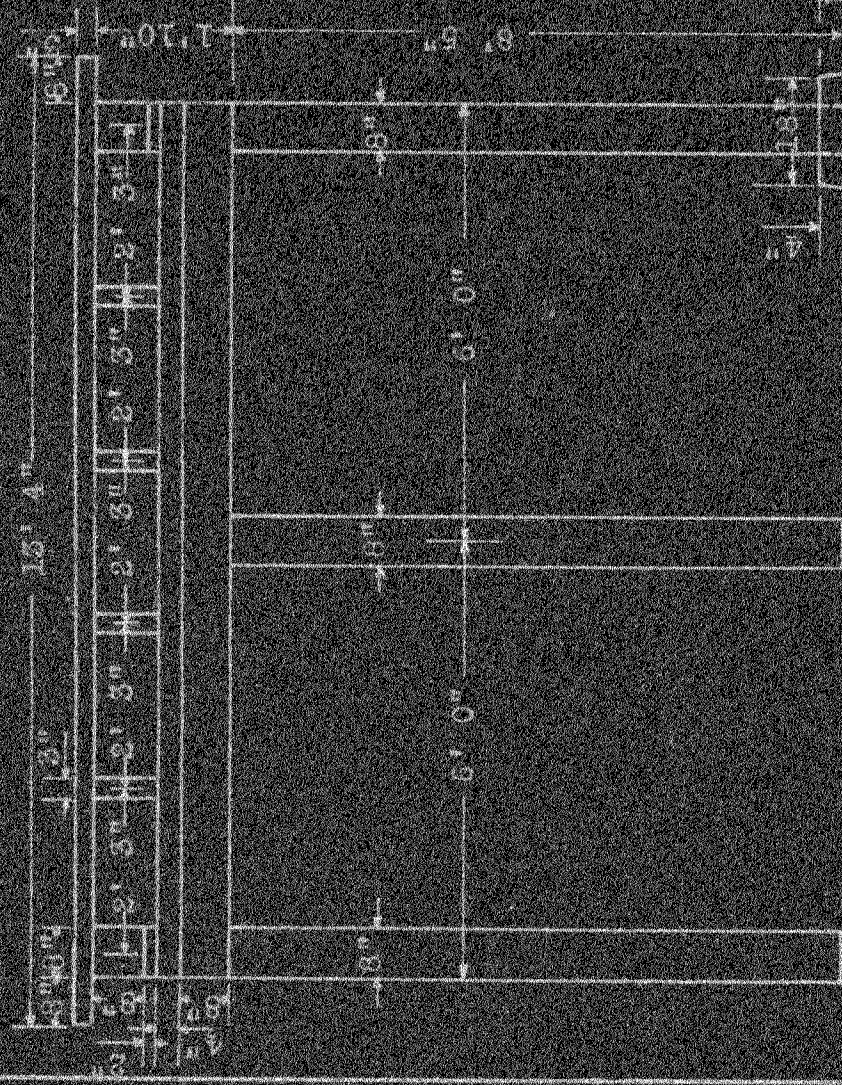
The floor system will be supported on 8" x 8" timbers. The timbers next to the railroad track will be 8' 4" long 5' 4" on centers and will rest on concrete foundations seated on solid granite. Three will be used. The same type

of construction will be used for supporting the floor at the pilasters. Two uprights will be used instead of three and they will rest on the projections of the pilasters. The uprights will be 5' 7" long.

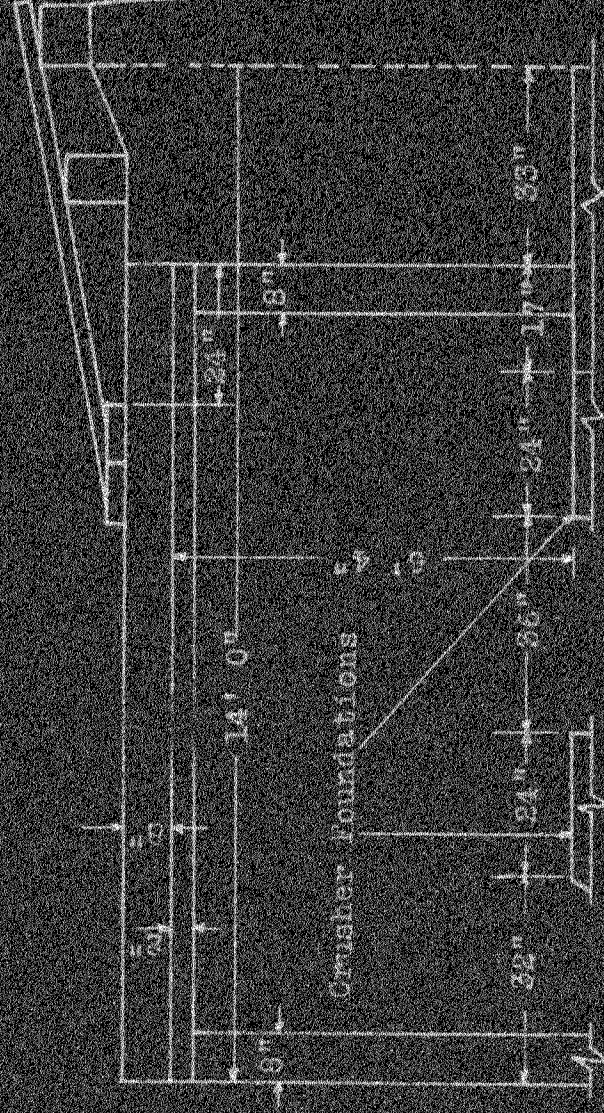
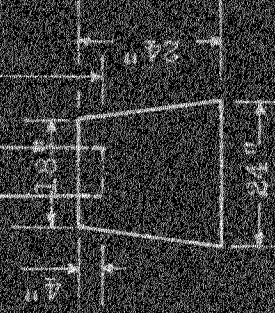
The distance from the mouth of the crusher to the underside of the floor is 3' 6". It will be necessary to install a hopper from the floor to the mouth of the crusher. The hopper will be 3' 6" high, 13" x 40" at the crusher and 25" x 40" at the floor of the platform. An opening 25" x 40" will be cut in the floor. The hopper will be constructed of No. 3 gage sheet iron. 1/2" rivets 4" on centers will be used in constructing the hopper.

A frame will be erected over the platform to serve as hand rails and as a support for wind breaks and a sun shade. The side next to the retaining wall will be left open. The frame will be of 2" x 4" timbers.

LOADING PLATFORM



END ELEVATION



SIDE ELEVATION

SCREEN ASSEMBLY

Screens are made up to fit the individual needs and not to any particular set of specifications. For granite a heavy duty perforated sheet steel screen equipped with a dust or sand jacket and roller supported is recommended.

The size of the product of the crusher ranges from $\frac{3}{4}$ " to $2\frac{1}{2}$ " in diameter. The screen will be in three sections. One punched for $\frac{3}{4}$ " material, one for $1\frac{1}{2}$ " material and one for $2\frac{1}{2}$ " material. The sand jacket is made of wire mesh with $5/16$ " perforations.

A screen 12' 0" long and 36" in diameter to revolve at a speed of 42 R. P. M. was recommended by the crusher manufacturer. After a careful investigation of this recommendation and a study of similar plants this screen was accepted.

SCREEN

The screen is made of No. 8 gage sheet steel. Each section is to be 4' 0" long. The perforations are punched in a flat section of the sheet steel and then it is rolled. The screen is 36" in diameter.

SAND JACKET

The sand jacket is of wire mesh with $5/16$ " perforations. It is to be placed over the section of the screen with $\frac{3}{4}$ " perforations. It is 48" in diameter and 36" long.

REINFORCEMENT

The sections of the screen are lined up and three $2\frac{1}{2}$ " x $2\frac{1}{2}$ " x $3/8$ " angles are bolted to them. The bolts are on

12" centers. This type of assembly is very strong and amply supports the screen. The sand jacket is attached to the reinforcements.

BEARINGS

The front end of the screen rests on 10" trunnion rollers. The trunnion track is attached to the end of the screen and to the reinforcement. The trunnion track gives the necessary circular reinforcement to the screen and forms an anchor for the reinforcement. The rollers and track are of best grade, high carbon steel.

The rear end of the screen is supported by a single shaft. The shaft is attached to screen by a spider. The spider is a cast iron wheel with three spokes supporting a hub for the shaft and has gear teeth on the rim. The screen is powered from this end. The reinforcement is also attached to the spider which gives the necessary circular reinforcement to the rear end of the screen. The shaft has one steel, babbitt lined, adjustable bearing.

GEARS

The gear on the end of the screen has 85 teeth. It is the ring gear. The pinion gear has 15 teeth. The bucket must revolve at 42 R. P. M. This would give the small gear an R. P. M. of 237.8. Power is transmitted to the screen by means of a chain and two sprockets. The sprocket on the elevator shaft has 29 teeth and revolves at an R. P. M. of 90.2. Eleven teeth will be required on the small sprocket driving the screen.

SPROCKET WHEELS

The sprocket wheels are made of high grade cast iron with chilled rims. They are of the type known as solid sprockets.

Chilled rim sprocket wheels have smooth hard rim surfaces with deep chills which make them especially well adapted for service in places where abrasive materials are present. One sprocket wheel has 29 teeth and a pitch diameter of $12\frac{3}{4}$ ". The other sprocket has eleven teeth and a pitch diameter of $5\frac{3}{4}$ ".

CHAIN

The type of chain used for driving the screen is standard detachable chain.

Standard detachable chain is the simplest and best known type of malleable link belting.

The approximate links in 10 ft of chain is $25\frac{1}{2}$.
The approximate ultimate strength is 11,000#s.

Weight in pounds per 100 ft. - 442

Pitch inches - 4.72

BED

The bed of the screen is to be made of 8" x 8" timbers. Two pieces of 8" x 8" timber 20' 0" long will be required for the frame. The cross members will be of 8" x 8" timbers 12' long. Two will be required. One is to be placed under the front end of the screen to carry the trunnion rollers and one is to be placed under the rear end of the frame. It will carry the gear for revolving the screen. The frame must be raised 9" from the front cross member to give sufficient clearance for the trunnion rollers. Three pieces of

3" x 10" timber 12" long will be used between both members of the frame and the cross member. The rear end of the frame rests directly on the cross member.

The bed is to be bolted together with 5/8" bolts. Heads and nuts will be countersunk.

INSTALLATION

The sand jacket must be placed over the sand shute. This will locate the front end of the screen 3' 6" from the inside face of the front wall of the bins. This will place the front cross member 5' 2" from the end of the frame. The rear end of the bed will project 2' 0" beyond the second partition.

Some stone passes through the crusher that is too large to be screened. It goes through the screen and slides out of the rear end. It will be necessary to build a shute to carry this stone clear of the bins. A height of 3' 2" above the top of the bins is required to give sufficient clearance for this shute. This will raise the bed of the screen 4' 8" from the top of the bins.

As designed the screen has a slope of 27" in its length of 12'. This is ample for efficient operation. The bed will be set level 4' 8" from the top of the bins.

At this stage of design it was decided to place a cap of 3" x 8" timbers on top of the walls of the bins. This will distribute the weight of the screen over a larger area, serve as a cushion to lower the vibrations, and make it much easier to install the screen. The timbers are to be attached to the bins with 3/4" bolts 24" center to center set in the

concrete. The nuts are to be countersunk.

The supports for the bed of the screen are to be made of three pieces of 3" x 10" timber 3' 3½" long spaced 18" center to center and capped with three pieces of 3" x 10" timber 3' 6" long. The ends of the frame are to be braced with 3" x 10" timbers offset 18" at the bottom and attached to the frame at the top. This type of construction further distributes the load and cuts down on the vibration. It also makes replacement very easy. Four supports are necessary. The center line of the supports used in front will be 3' 10" from the inside face of the front wall. The center line of the supports in the rear will be 14' 2" from the center line of the front support.

The front ends of the frame will become an integral part of the supports for the shaft of the elevator and screen. The ends of the frame will rest on supports of 3" x 10" timber. Each support will be made of three pieces of timber put together to resemble a channel. The lower shaft on the elevator has two bearings on the frame of the elevator and one to be attached to a support built up from the bed of the crusher. This support will be built of two pieces of 3" x 10" timber 2' 9" long, spaced 20" on centers and capped with a 3" x 10" timber 24" long.

The main shaft will have two bearings on the end of the elevator frame and one to be supported. The support for this bearing will be the same type of construction. The uprights will be 4' 3" long.

A piece of 8" x 8" timber 12' 0" long will be placed on top of the bins directly under the front cross member of

the screen supported at the third points. The supports will be of 3" x 10" timber. A bracing timber will extend from the base of each support to the top of the outside support. This type of construction was considered necessary to give the crusher assembly the necessary rigidity and sufficient support. It was placed under the front end of the screen because this end receives the stone from the elevator and carries the heaviest load.

All of the supports will be boarded up on the outside. A roof will be built on the rear end of the bins extending from the timber cap to the top of the support. This cover protects the chute for the oversize stone and serves as a brace for the bed of the screen. The boarding on the outside of the supports serves the same purpose.

A piece of 3" x 10" timber will be placed across the front supports and just over the screen bed. This gives additional stiffness to the supports of the screen. The frame of the elevator is to be attached to this timber with 3" x 10" timbers. This ties the elevator and screen assembly together and prevents any possible sway of the top of the elevator.

As an additional precautionary measure the frame of the elevator will be tied to the cap on the top of the bins with two 4" x 4" timbers. The timbers will extend from the frame of the elevator to the outside edge of the end walls of the bins.

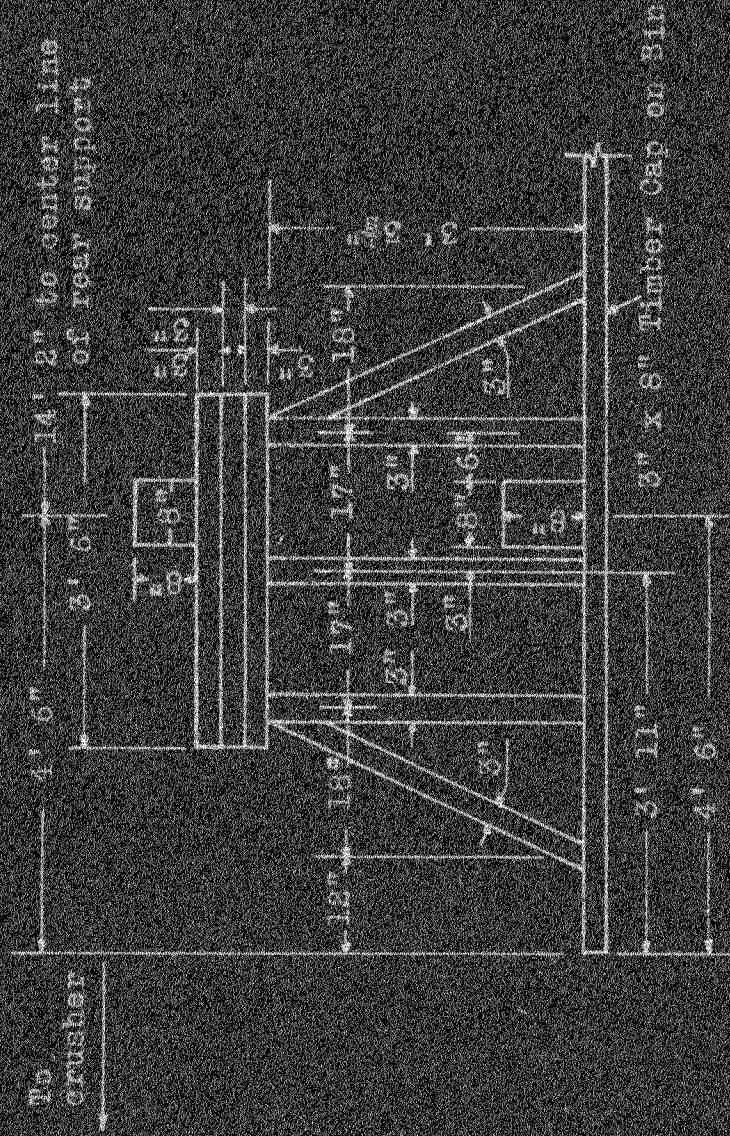
All of the timber in the elevator and screen assembly will be protected with at least three coats of good quality paint.

The point of discharge of the buckets is 4' 0"

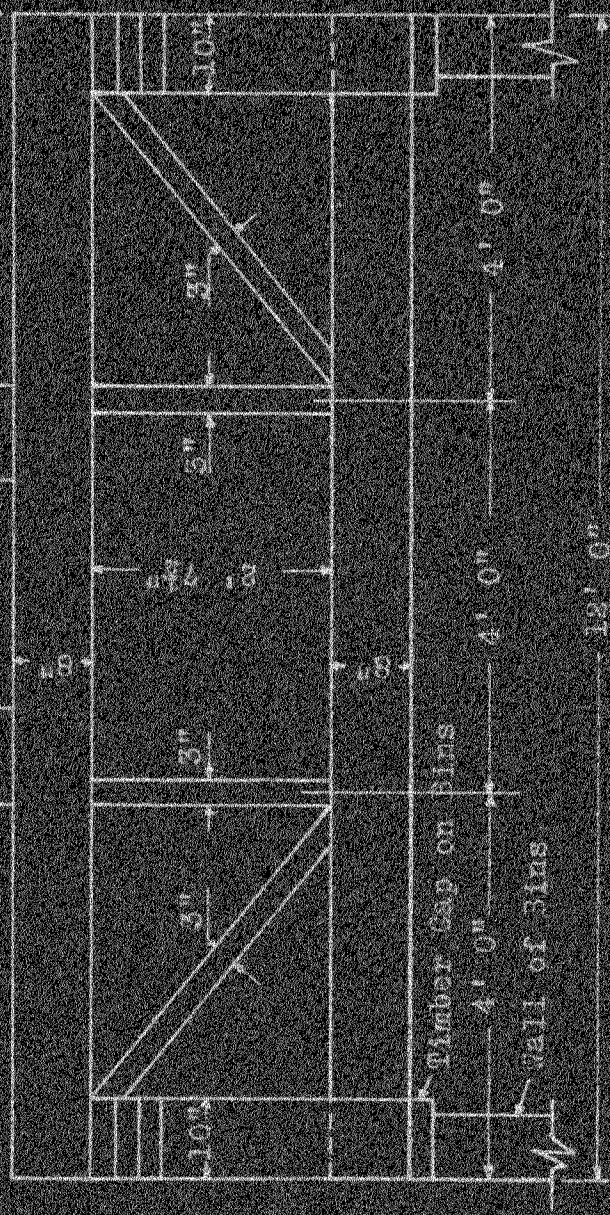
higher than the end of the screen. The actual distance from the point of discharge to end of screen is 4' 8". A chute will be installed to carry the stone from the elevator to the screen. It will be of No. 5 gage sheet iron, 4' 8" long and 8" deep. It will be supported by two pieces of 3" x 10" timber. One piece of timber will rest on the bed of the screen and one will be attached to the support of the elevator shaft.

Lump sum bids are to be requested for the elevator and screen assembly delivered on the job complete and ready for installation.

FORUM AND SUPPORT



WITTENBERG, EDWARD



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TAILING BINS

When the design of the plant was first started the stone too large to go through the screen was to be carried clear of the bins by a wooden shute and dropped on the ground. When the pile was large enough it was to be loaded into the trucks and sent through the crusher. At this stage of the design the superintendent of the quarry estimated that it would be cheaper to build a small bin of wood to receive this stone. This will require another unloading shute.

Two rubble masonry walls 8' high, 24" thick and 7' long, 10' center to center of walls are to be built. The bin is to be 7' wide, 7' long and 10' high. The foundation walls are to be built wider than required. This is to take care of a possible increase in the size of the bin.

Design:

One end of the bin is to rest on a piece of 10" x 10" timber placed on the projection of the foundation of the bins and the other on a piece of 10" x 10" timber laid on the foundation walls. The floor of the bin is to be of 2" x 8" timber on 3" x 10" stringers 12" on centers. On the sides two 3" x 10" timbers will be used. The flooring will be laid with a one inch space between the boards. The frame for the sides and ends will be of 6" x 6" timbers braced with 4" x 4" timbers. The walls will be of 2" x 8" boards.

One unloading shute will be required and will be attached before the walls are boarded up.

Rubble masonry:

2(8' x 2' x 7') = 224 cu. ft. 9 Perch

POWER TRANSMISSION AND SPEED OF OPERATION

As designed the power plant is an electric motor rated at 870 R. P. M. and equipped with an 8" pulley. Power is transmitted to the crusher, which has two 36" fly wheels used as pulleys, by means of a continuous 10" 5 ply belt.

8:36 - X:870

Motor R. P. M. 870

X = 193.3 R. P. M.

Crusher R. P. M. - 193.3

Power is transmitted from the crusher to the elevator through a countershaft by an 8" 4 ply belt. The countershaft was necessary to reduce the speed and to keep the belts out of the way. The crusher has a 36" pulley and the countershaft a 36" pulley and a 14" pulley. The belt from the crusher goes to the 36" pulley. The R. P. M. of the crusher is 193.3, therefore the R. P. M. of the countershaft pulleys is 193.3.

R. P. M. of countershaft = 193.3

Power is transmitted from the countershaft to the elevator. An 8" 4 ply belt goes from a 14" pulley on the countershaft to a 30" pulley on the elevator. The R. P. M. of the 14" pulley is 193.3.

14:30 - X:193.3 Countershaft R. P. M. - 193.3

X = 90.2 R. P. M. Elevator Pulley R. P. M. - 90.2

Power is transmitted from the pulley to the elevator chain friction discs by means of gears. The gear on the shaft of the pulley has 15 teeth and the gear on the elevator shaft has 75 teeth. The R. P. M. of the small gear is 90.2. There are five times as many teeth on the large gear as on the small gear, therefore, the R. P. M. of the large gear will be one-fifth of the R. P. M. of the small gear.

$$\frac{90.2}{5} - 18.04$$

Small gear R. P. M. - 90.2

Large gear R. P. M. - 18.04

The large gear and the friction disc being on the same shaft have the same R. P. M., 18.04. The diameter of the disc is 18". Its circumference is 4.7124 ft. Rate of travel of chain is circumference of disc times the R. P. M.

$$(18.04)(4.7124) = 85$$

Rate of travel of chain is 85' per minute. Each bucket occupies one foot of chain, therefore, 85 buckets per minute pass the mouth of the crusher.

The elevator shaft also powers the screen. Power is transmitted to the screen by means of two sprockets, a chain and two gears. The sprocket on the elevator shaft has 29 teeth and travels at an R. P. M. of 90.2. The chain running on this sprocket travels at the rate of 566.7 ft. per minute. The sprocket driving the gears for the screen has 11 teeth.

$$29:11 - X:90.2 \quad 29 \text{ tooth sprocket R. P. M.} - 90.2$$

$$X = 237.8 \quad 11 \text{ tooth sprocket R. P. M.} - 237.8$$

The small sprocket turns a shaft with a 15 tooth gear. The R. P. M. of the gear is 237.8. The 15 tooth gear turns an 85 tooth gear.

$$15:85 - X:237.8 \quad 15 \text{ tooth gear R. P. M.} - 237.8$$

$$X = 42 \text{ R. P. M.} \quad 85 \text{ tooth gear R. P. M.} - 42$$

The 85 tooth gear is on the end of the screen, therefore, the R. P. M. of the screen is 42.

SUMMARY OF MATERIAL

1 Motor
1 Crusher
1 Elevator
1 Countershaft
1 Screen Assembly
47' 10" of 10" 5 ply rubber belting
117' 0" of 8" 4 ply rubber belting
1 Hopper platform of crusher
4 Unloading Shutes
1 Shute Elevator to Screen
117 Perch rubble masonry
87.997 cu. yds. 1:2:4 concrete
3155#s reinforcing steel
8.0 M F. B. M. timber
200#s Nails
Bolts, $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1"
300 cu. yds. dirt

CHAPTER NO. III
ESTIMATE OF COST OF CONSTRUCTION

ESTIMATE OF COST OF CONSTRUCTION

1 Motor delivered and installed @ \$1140.00	\$1140.00
1 Crusher delivered and installed @ \$2565.00	2565.00
1 Elevator (
1 Countershaft (delivered,	
1 Screen Assembly(and installed @ \$1900.00	1900.00
47' 10" of 10" 5 ply rubber belting @ \$1.00	47.84
117' 0" of 8" 4 ply rubber belting @ \$0.60	70.20
1 Hopper platform to crusher @ \$24.80	24.80
4 Unloading Shutes delivered and installed @ \$44.55	188.20
1 Shute Elevator to Screen	15.00
117 Perch rubble masonry @ \$4.00	468.00
87.997 cu. yds. 1:2:4 mix concrete @ \$15.00	1319.96
8.0 M F. B. M. timber @ \$20.00	160.00
200#s Nails, per hundred @ \$3.90	7.80
Bolts, $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1" @ \$20.00	20.00
300 cu. yds of dirt @ \$0.30	90.00
Labor	200.00
Incidentals	100.00
Total	<u>\$8326.80</u>

This estimate of cost of construction is based on prices received on all of the machinery to be installed and prices received for all materials to be used. The only possible overrun or underrun will be due to some changes that might possibly be made on construction. It is estimated that the actual cost of construction will not vary more than 4% either way.

CHAPTER NO. IV
METHOD OF CONSTRUCTION
AND
NECESSARY MODIFICATION OF PLANS

METHOD OF CONSTRUCTION AND NECESSARY MODIFICATION OF PLANS.

As soon as the design was finished the overburden on the plant site was removed. The foundations for the bins were started and carried to completion exactly as designed. The labor used was men from the quarry. As soon as the foundations were completed the men went back to the quarry and the foundations allowed to set for 30 days. The crew came back and filled the space enclosed by the foundation walls with earth, rubble, spawl and sand from an old crushing plant. This was wet down and allowed to thoroughly compact.

After the fill had compacted a superintendent of construction was hired and all of the forms built according to design. On the advice of the elevator manufacturer an additional support was to be placed under the elevator at the vertical support resting on concrete foundations. This support was to be set at right angles with the elevator frame and was to be attached to the frame of the elevator directly behind the vertical support. The supports were to be of 3" x 10" timber and to rest on concrete foundations seated on solid granite. This necessitated two additional foundations. This is the only increase made in the amount of concrete used.

The steel was placed as the forms were built. Sections of $\frac{1}{2}$ " iron pipe 3" long, 24" on center, were put in the bins resting on the rubble masonry foundations and extending up into the walls of the bins. This was a precautionary measure adopted by the superintendent of the quarry. All bolt heads set in the concrete were placed between two pieces of $\frac{1}{2}$ " round iron 6" long to prevent any possible turning of the heads in the concrete.

Provision was made for installing an 8" x 8" timber cap on top of the walls of the bins.

The method of attaching the elevator to the bins was changed. Two 6" x 12" timbers are to be bolted to the bins extending from a point 12" below the first elevator support on the bins to the top of the bins, and the timbers originally designed to be attached to the bins are to be attached to these timbers. This distributes the load of the elevator over a larger area and tends to reduce vibration.

It was decided to leave an opening 30" square 12" from the top in the rear wall of the bins to carry the shute to the tailing bins. This type of construction was used instead of carrying the shute over the top.

This opening and the opening for the sand shute cut down on the capacity of the bins but in no way decreased the efficiency of the plant or interfered with its continuous operation.

After the forms were completed and inspected pouring of the concrete was started. At the end of each day's run construction joints were made. The pouring was completed as rapidly as possible.

The concrete was allowed to set for 30 days, and then the work of installation was started. With the exception of the elevator the installation was carried forward as designed. A few additional braces were installed in the screen assembly. A piece of 3" x 10" timber was placed on each end of the crusher foundation extending up to and being attached to a stringer of the platform. The piece of timber resting on top of the retaining wall and supporting the timber ramp to the loading platform of the crusher was changed from 8" x 8" to

8" x 10".

Upon completion of the installation all of the timber construction was painted. As soon as the paint dried the plant was given a final inspection and declared ready for operation.

METHOD OF POURING CONCRETE

The mixer was centrally located and runways built to the different units of the structure. Concrete was hauled from the mixer to the place of deposit in wheel barrows. It was moved as rapidly as possible and handled in such a manner that the ingredients did not become separated.

CHAPTER NO. V
COST OF CONSTRUCTION

COST OF CONSTRUCTION

The cost of construction is taken from records kept on the job.

1 Motor delivered and installed @ \$1140.00	\$1140.00
1 Crusher delivered and installed @ \$2565.00	2565.00
1 Elevator (
1 Countershaft (delivered,	
1 Screen Assembly(and installed @ \$2000.00	2000.00
47' 10" of 10" 5 ply rubber belting @ \$1.00 per ft.	47.84
117' 0" of 8" 4 ply rubber belting @ \$0.60 per ft.	70.20
1 Hopper platform to crusher	24.80
4 Unloading Shutes delivered and installed @ \$44.55	188.20
1 Shute Elevator to Screen	15.00
117 Perch rubble masonry @ \$4.00	468.00
89.155 cu. yds. 1:2:4 concrete @ \$15.00	1337.33
8.6 M F. B. M. timber @ \$20.00	172.00
200#s Nails, per hundred @ \$3.90	7.80
Bolts	24.53
400 cu. yds. dirt @ \$0.30	120.00
Labor	273.70
Incidentals	50.00
Total	<u>\$8504.00</u>

Cost of construction	\$8504.00
Estimated cost of construction	\$8326.80
Overrun	<u>\$ 177.20</u>

The overrun is 2.128%. The estimated overrun or underrun was 4%.

The motor was manufactured by and purchased from the Westinghouse Electric and Manufacturing Company of Pittsburgh, Pennsylvania. The Atlanta branch is at 426 Marietta Street, N. W. It was installed by the Georgia Power Company, 75 Marietta Street, N. W., Atlanta, Georgia.

The crusher was manufactured by the Universal Crusher Company, 625 C Avenue West, Cedar Rapids, Iowa, and purchased from R. S. Armstrong & Bros. Company, 676 Marietta Street, N. W. Atlanta, Georgia.

The elevator, countershaft, and screen assembly was manufactured by the Webster Manufacturing Company, 4500-4560 Cortland Street, Chicago, Illinois, and purchased from the Good Roads Machinery Company, Kenett Square, Pennsylvania.

The belts were manufactured by the B. F. Goodrich Rubber Company of Akron, Ohio, and purchased from the J. M. Tull Rubber and Supply Company, 285 Marietta Street, N. W., Atlanta, Georgia.

The rest of the material was purchased from local dealers.

CHAPTER NO. VI

METHOD AND COST OF OPERATION

METHOD OF OPERATION

The method used in operating the Crushing Plant is the result of a careful study of similar plants plus years of experience in quarrying granite. Overhead is kept down by the use of the simplest and most efficient tools possible. There is no complicated machinery connected with the plant and very little training is necessary for the crew. Any experienced quarry laborer can function very efficiently.

As stated in the Chapter on Design the bins of the plant will not take care of a day's run. This is unnecessary as railroad cars are available daily and this insures the plant against suspending operations. The bins are not primarily designed for storage but for the purpose of collecting the different size stones separated by the screen. They are of such capacity, however, as to insure a day's run even when small orders are to be filled.

The crew of the plant proper consists of two men. They feed the crusher, make minor repairs, and do the odd jobs necessary to keep the machinery in motion. The power plant is taken care of by the quarry electrician. Practically all of the machinery is electrically driven, either directly or indirectly. Since the motor of the plant has dust proof bearings and an automatic switch the time devoted to it by the electrician is almost negligible. When the plant is not in operation the crew is used elsewhere on the quarry. They assist the other crews or collect waste material and pile it near the road. This cuts down on the cost of operating the trucks. The material is collected by raking it up into small piles, loading it into wheel barrows, and moving it to the roads. The roads are so located that the dis-

tance the material is moved in the wheel barrows is very short.

When the plant is in operation three men are generally able to load the three trucks used fast enough to keep a continuous flow of spawl for the crusher. The trucks are loaded by hand. The tools used are short handled shovels and pitchforks for small material. Rubble is loaded by hand, and if a piece is too large for one to load it is broken up. The ramp dump enables the trucks, which have dump bodies of two ton capacity, to unload on the hopper platform as near as practical to the mouth of the crusher. The spawl from the sheds is moved to the plant in wheel barrows normally. Occasionally, enough has collected to warrant the use of a truck. The sheds are cleaned daily and generally the material is moved to the plant during this operation.

Small stones are fed to the crusher with long handled rakes and pitchforks. Large pieces of rubble are raked into the hopper with L shaped hooks made of half inch round iron, or tossed in by hand. The mouth of the crusher will take stones larger than the rakes and pitchforks can move. Most of the stone is raked or tossed into the crusher from the stock piles. Occasionally the trucks are dumped directly into the hopper.

As the stone is crushed it simply falls out of the crusher into a chute and from there directly into the conveyor or elevator. It is then carried to the rotary screen located at the extreme top of the plant. As the crushed stone enters the screen the granite sand is separated from it by the sand jacket. The stone is separated into three sizes and deposited in the bins. Any stone too large slides out of the screen,

which is open at both ends, into the tailing bin. Normally the sand goes down a shute to a location where it will not be in the way until the accumulated material reaches large proportions. At present the excess sand is being used to make a fill between the shed and the crushing plant.

The three bins of sized material are emptied by means of shutes located at the floor level of the bins on the wall nearest the railroad tracks. When lowered they clear the top of the car about two feet and deposit the crushed stone in the middle of the car longitudinally. The shutes serve as gates for the bins, and to stop the flow of crushed stone it is only necessary to raise them. When the product is to be used locally the trucks are driven up the railroad tracks and loaded in the same manner. The track has been filled with granite sand until it is almost level with the top of the rails. This enables the drivers to handle the trucks as easily as on the open road. The shute of the tailing bin is located on the end wall and parallel to the railroad track. The stone in this bin is loaded into trucks and sent through the crusher again.

The sand is loaded into the cars or trucks directly from the shute which is movable. Since the amount of sand is small in proportion to amount of stone crushed, part of the railroad car must be loaded by hand. Occasionally a continuous belt driven loader is used. If this is not available the laborers use shovels to complete the loading. Sand for local trade is handled in the same manner.

When the plant is shut down, if possible, the bins are left full. This enables the loading of cars to start as soon as they are placed and before the plant is started. The

trucks are kept in operation until all available space on the ramp is filled with spawl. The material from the sheds can always be dumped on these stock piles.

COST OF OPERATION

The crushing plant operates nine hours a day, employing a crew of two men. Two methods of operation are used and they will be designated as Method #1 and Method #2.

Method #1 covers the operation of the plant when granite for the crusher is obtained from the stock piles accumulated on the quarry and at the cutting sheds. Three trucks are used in transporting the material to the crusher and three men are required to load these trucks. This method uses the entire time of five men and three trucks with drivers.

2 men @ \$3.00 per day operating plant	\$6.00
3 men @ \$3.00 per day loading trucks	9.00
2 men @ \$0.35 per hr. for 9 hrs. (Truck Drivers)	6.30
Total	\$21.30

Method #2 covers the operation of plant and cleaning of the quarry. Both operations being carried on at the same time. Cleaning requires the service of three additional men. This method uses the entire time of eight men and three trucks with drivers.

2 men @ \$3.00 per day operating plant	\$6.00
3 men @ \$3.00 per day loading trucks	9.00
3 men @ \$3.00 per day cleaning quarry	9.00
2 men @ \$0.35 per hr. for 9 hrs. (Truck Drivers)	6.30
Total	\$30.30

When the quarry is cleaned when the plant is not in operation the time of the men is charged against quarrying. The cleaning is done by the regular quarry force during spare

time between quarry operations. When cleaning and crushing is done at the same time it is necessary to take the men from another job and then their time is charged against the cost of operation of the crushing plant.

When the plant is not operating the crew of two men are placed on other jobs and their time is charged against that job. They are trained to function in any capacity on the quarry, except the cutting sheds.

The plant is operated on an average of 112 days per year.

Method #1 - Labor

112 days @ \$21.30 per day	\$2385.60
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Method #2 - Labor

112 days @ \$30.30 per day	\$3363.60
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INTEREST

The plant cost \$8504.00

\$8504.00 @ 6% - \$510.24

DEPRECIATION

The depreciation of the plant averages 10%

\$8504.00 @ 10% - \$850.40

MAINTENANCE

Maintenance including upkeep and replacements.

Maintenance - \$600.00 per year

ELECTRICITY

The cost of electricity is $2\frac{1}{2}$ ¢ per kilowatt hour.

1 kilowatt - 1.34 H. P.

$\frac{50}{1.34}$ - 37.31 kilowatts per hour

$(37.31)(9)(112) = 37608.48$ kilowatt hours

$(37608.48)(.025) = \$940.21$

COST OF OPERATION FOR ONE YEAR

Interest on investment	\$510.24
Depreciation	850.40
Maintenance	600.00
Electricity	940.21
Total	\$2900.85

Method #1

Labor	\$2385.60
Other costs	2900.85
Total	\$5286.45

Method #2

Labor	\$3363.60
Other costs	2900.85
Total	\$6264.45

Total production for one year = 20,160 tons

Average price per ton is \$1.15

$(20,160)(1.15) = \$23,184.00$

INCOME FROM PLANT

Method #1

Gross Income	\$23,184.00
Operation	5,286.45
Net Income	\$17,897.55

Method #2

Gross Income	\$23,184.00
Operation	6,264.45
Net Income	\$16,919.55

From these figures it can be seen that the crushing plant not only keeps the quarry clean but is a paying proposition when operated under either one of the methods used.